

The Journal of Bone and Joint Surgery*

The Official Publication of
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The American Academy of Orthopaedic Surgeons
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CIRCULACIÓN DEL EXTREMO SUPERIOR DEL FÉMUR (Circulation of the Proximal End of the Femur). Jorge Zarazaga. *Revista de Ortopedia y Traumatología*, XI, 26, 1941.

By combining roentgenographic and transparency methods, investigations were undertaken on cadavera ranging from foetuses nine months old to those of persons fifty-four years old. The author believes, as most authors do, that the proximal end of the femur gets its blood supply from three different vascular regions: the diaphysis from the femoralis profunda (first perforating), and the epiphysis from the posterior and anterior circumflex arteries, and from the artery of the round ligament.

According to his observations, the artery of the round ligament is of definite importance to the blood supply of the femoral head in 75 per cent. of the cases, anastomosing with the epiphyseal branches of the other vascular regions. In 25 per cent. of the cases it was found that this artery ends in the fovea capitis. In the nine-months foetus the artery ends in the fovea capitis, but as age advances, it penetrates the head to anastomose with the other arteries.

The posterior circumflex artery supplies blood to the largest part of the proximal end of the femur, including the head and two-thirds of the trochanteric mass, and anastomoses with the nutrient artery and that of the round ligament.

The anterior circumflex, through its subepiphyseal branch, nourishes part of the epiphyseal cartilage, and, when growth is over, supplies the blood for a seventh of the epiphysis and a third of the trochanteric mass.

The nutrient artery is a factor in the blood supply of the proximal end of the femur, anastomosing with branches of both circumflex arteries.—*Leon Avila, Jr., San Salvador, El Salvador.*

THE TREATMENT BY LOCAL INJECTIONS OF SOME FORMS OF LOW BACK PAIN, SCIATICA AND LUMBAGO. AN EDITORIAL. *Rheumatism*, II, 1940.

Injection of the correct solution into painful muscles of the low back has produced in many cases dramatic results. It was presumed that the anaesthetic solution paralyzed the motor nerve centers in the muscles, and thus caused the spasm to disappear. Recently doubts have arisen in regard to this hypothesis.

It is pointed out that in examining a painful back, acutely painful areas are found in the muscles. These localized points, when treated with heat and light massage, lose much of their tenderness to pressure. As this pain disappears, so do the symptoms from which the patients are complaining,—such as lumbago, sciatica, brachial neuritis, and other rheumatic manifestations. There are two possible explanations of this: (1) The pain was referred from nerve centers in a rheumatic nodule; (2) the spot was an ischaemic area, and when this was rendered hyperaemic by heat and massage, the pain disappeared and thus the symptoms were relieved.

In most cases of non-articular rheumatic pain, myalgic spots may be readily demonstrated. If the sciatic or lumbar pain is due to some other cause, these points of pain are not present. When present, they usually lie along the edge of the quadratus lumborum, near the upper portion of the gluteus medius, and in the deep piriformis. Occasionally the upper edge of the gluteus maximus may be affected.

Treatment is based largely upon injection of a .025-per-cent. solution of procaine into the myalgic spots. The points of tenderness are marked with an iodine swab, and then about two cubic centimeters of the solution is injected into each spot. In most cases the pain is relieved immediately, and practically normal motion at the lumbar spine results. Within a few hours the original pain may return in an aggravated form, but this usually disappears. In some cases a series of two to three injections is necessary to produce a complete cure. A successful result may be expected in those in whom the muscle spasm is the cause of the pain and the consequent disability.—*H. M. Childress, M.D., Charleston, South Carolina.*

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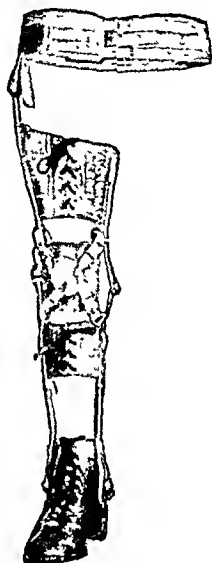
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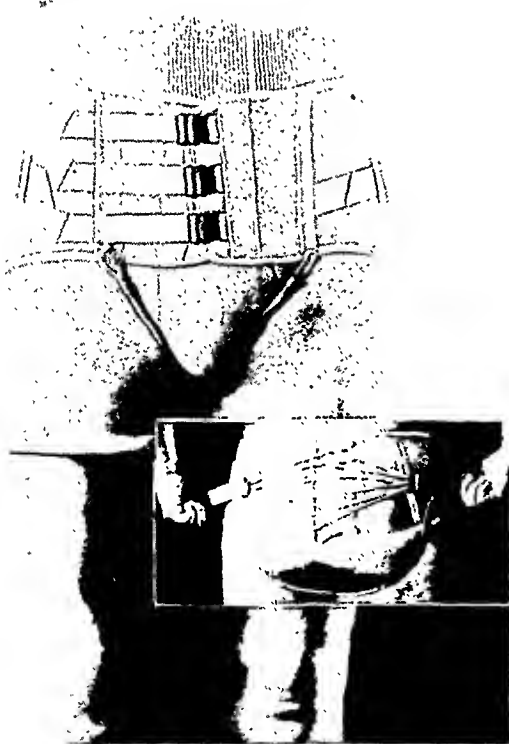
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SURGERY OF THE INTRINSIC MUSCLES OF THE HAND OTHER THAN THOSE PRODUCING OPPOSITION OF THE THUMB *

BY STERLING BUNNELL, M.D., SAN FRANCISCO, CALIFORNIA

With the progress of surgery certain finer aspects, which only a few decades ago would have seemed unimportant, are now essential.

The intrinsic muscles of the hand, though tiny, are important because they complete, with the long extensors and long flexors, the muscle balance in the hand. Normal position, normal motion, and even strength of the grip of the hand are dependent on this nice balance of these three sets of muscles.

With loss of action of the intrinsic muscles the thumb cannot oppose or adduct. It lies to the side of the hand. The carpal and metacarpal arches are flat and the fingers are clawed. They cannot simultaneously flex in their proximal joints and extend in their distal two joints, and are practically devoid of lateral motion. The hand has lost its skill and finer movements.

In hands not suitable for nerve repair, much of this imbalance can be

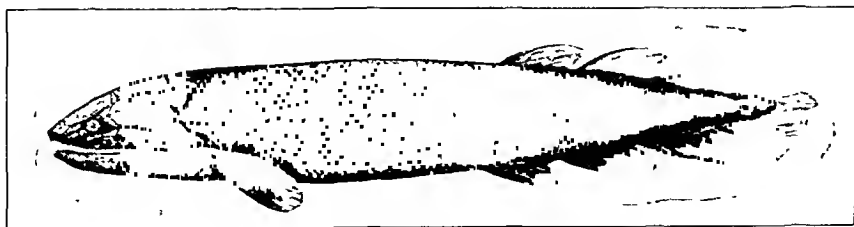


FIG. 1

Following the sharks, and just before the lung fishes, came the cross-opterygii, or fringe fins, with fleshy, jointed fins. It is conceded that this is the subclass which emerged from the water to become amphibia, and developed lungs and limbs for terrestrial existence. (*Reproduced from "Fishes" by David Starr Jordan, by courtesy of D. Appleton-Century Co., Inc.*)

* Read at the Annual Meeting of The American Academy of Orthopaedic Surgeons at New Orleans, Louisiana, January 16, 1941.

corrected surgically by tendon transfers. Cases include those of ulnar-nerve paralysis and those of paralysis of ulnar and median nerves. Also



FIG. 2-A

included are those with loss of intrinsic-muscle action of one or several digits. The correction of these has been found worth while in improving the function of the hand. It is possible, if the tissues are sufficiently flexible, to restore adduction of the thumb, curvature of the carpal and meta-carpal arches, some lateral motion of the fingers, and the ability to flex their proximal and extend their distal two joints simultaneously.

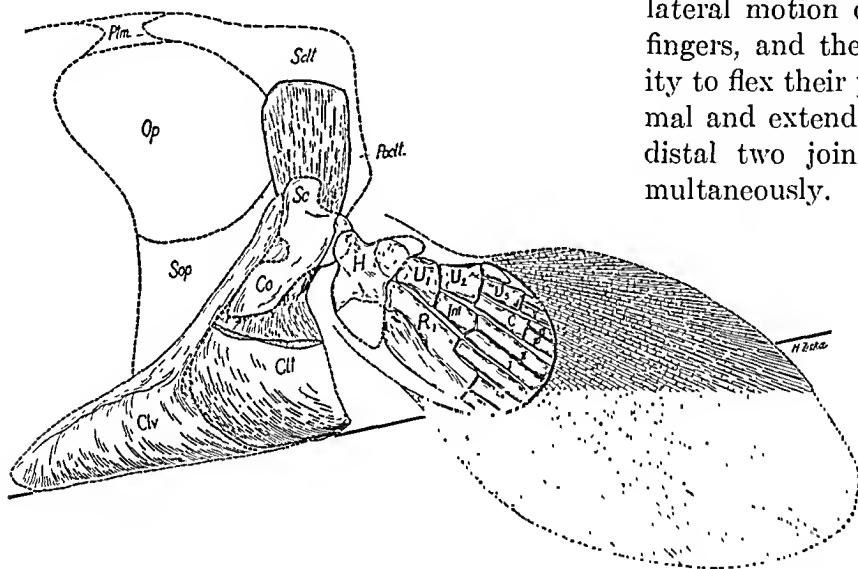


FIG. 2-B

Drawings show the story in fossils of how the pectoral fin of this early crossopterygian developed into the forelimb of the earliest known amphibian, eryops, thus changing from the multirayed fin to the five-digit type. (Reproduced by courtesy of *The American Philosophical Society*¹².)

Fig. 2-A: Original specimen of a pectoral fin of the fringe-fin fish, *sauripterus taylori* Hall, from the upper Devonian of Pennsylvania,—the conceded ancestor of the amphibia and all the vertebrates that followed.

Fig. 2-B: Median view of the right side of a reconstruction of the pectoral girdle and paddle of *sauripterus taylori*.

The function of opposition of the thumb, having been already discussed in a former paper⁶, is omitted in this one.

PHYLOGENETICS OF THE INTRINSIC MUSCLES OF THE HAND

From a search through the literature, and by dissection of the hands

of reptiles, mammals, monkeys, higher apes, and man for the origin of the intrinsic muscles, the author has reached the following conclusions:

Of all the muscles of the upper extremity, the intrinsic ones of the hand are primordial. They date back to the early fish where there was no arm but only a pectoral fin, the forerunner of the hand. Thus the hand in phylogeny preceded the arm, which developed later from higher cervical segments. The fish has not yet a neck. the bones of the pectoral fin articulating with the skull. Our intrinsic muscles are still supplied by the lower two nerves of the brachial plexus. The arm developed later from the neck for terrestrial existence.

The tetrapod, or four-limbed arrangement which became standard, commenced in the fish with pectoral and pelvic fins. The independent muscle ac-

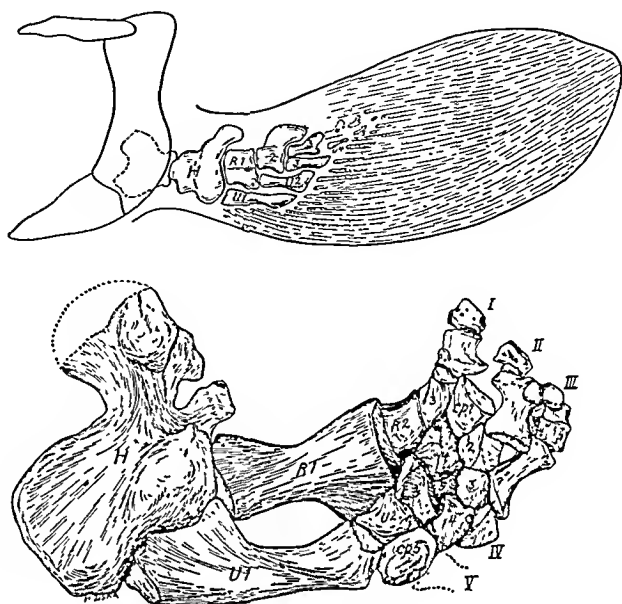


FIG. 2-C

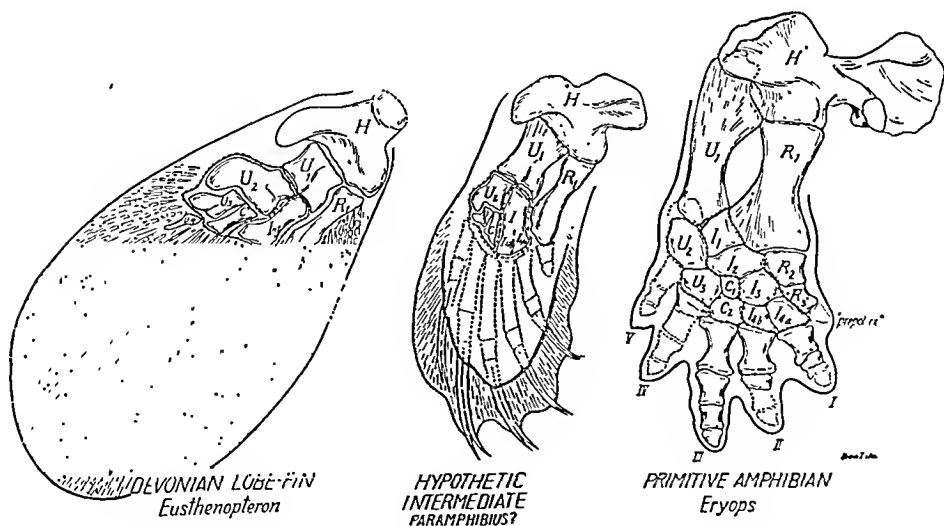


FIG. 2-D

Fig. 2-C: Comparison of the pectoral girdle and limb of a crossopterygian fish with that of eryops of the stegocephalian type, the earliest known amphibian showing homologous parts, according to Romer's theory.

Fig. 2-D: Transformation from the multirayed crossopterygian paddle to the pentadactylate hand of eryops and all subsequent vertebrates.

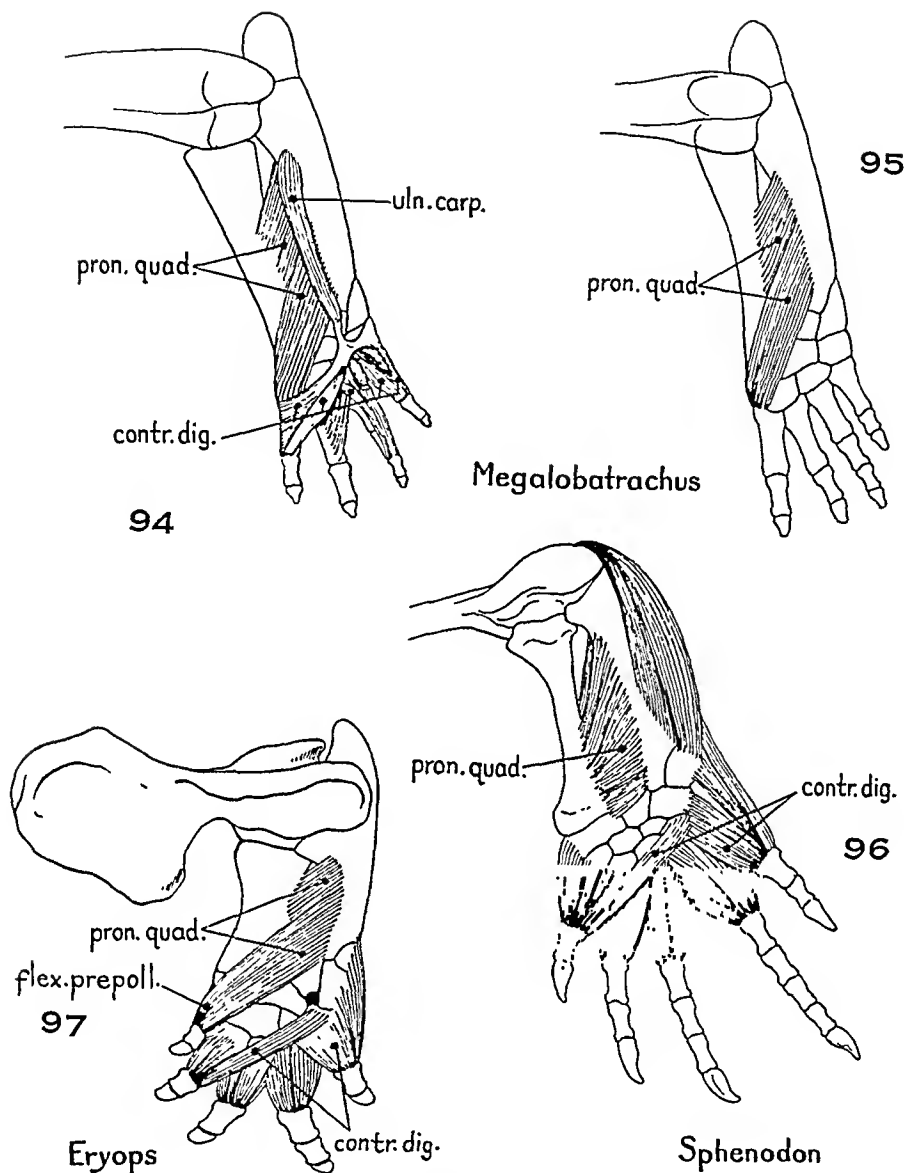


FIG. 3-A

Intrinsic hand muscles are well developed in amphibia, and, in fact, are the only muscles that control the digits. The arm muscles stop at the carpus or metacarpus. The arm developed after the hand from higher cervical segments. The intrinsic muscles in man are supplied by the lower segments of the eighth cervical and the first thoracic nerves, and the arm by higher segments up to the fifth cervical. The surprising development of the intrinsic muscles in amphibians is shown in this dissection of the hand of the giant salamander of Japan, megalobatrachus. (*Reproduced by courtesy of the Bulletin of the American Museum of Natural History*³⁰.)

Comparison of the deepest layer of forearm muscles and the contrahentes digitorum of megalobatrachus with those of the reptile sphenodon, and their inferred restoration in eryops.

tion of the rays of the pectoral fin was by the anlage of our intrinsic hand muscles. In development from fish through amphibians to man, the multirayed fin of the fish was reduced to the pentadactylate type. It is generally conceded that it was the crossopterygian fish, called "fringed

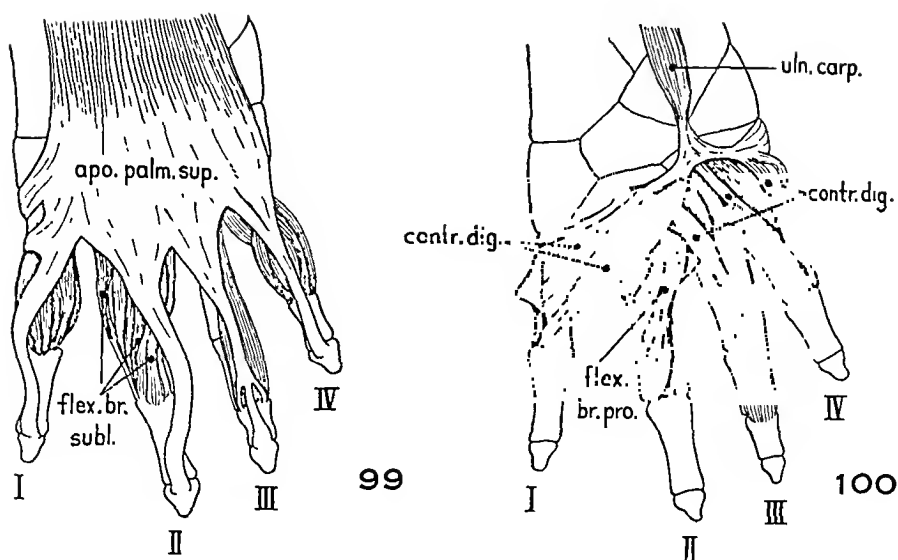


FIG. 3-B

99: Dissection of the hand of megalobatrachus showing superficial flexors and their attachment to the palmar fascia.

100: Showing deep flexors and their relation to the ulnocarpalis.

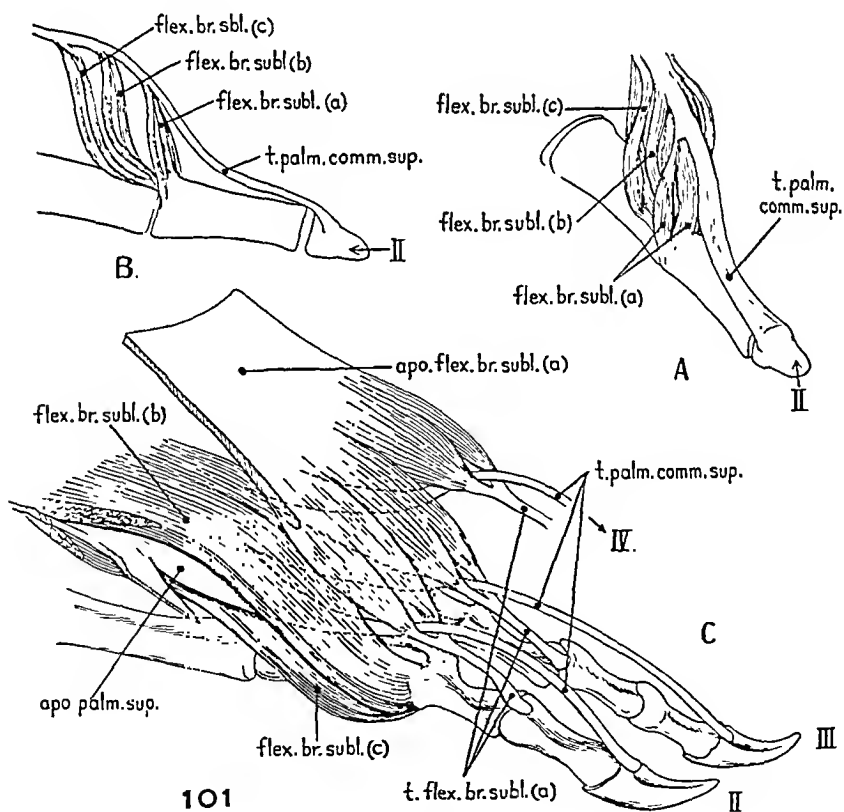


FIG. 3-C

Dissection of the second digit of megalobatrachus (A and B) and of the second, third, and fourth digits in the reptile sphenodon (C) to show the relation of the digital flexors to the palmar aponeurosis.

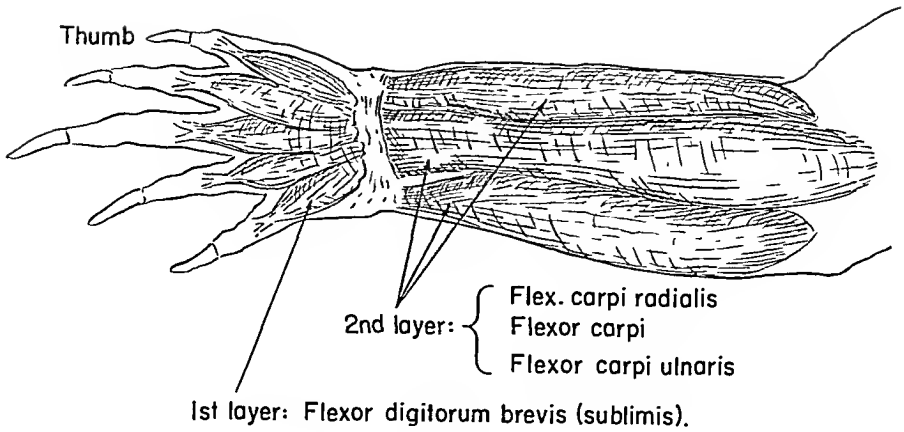


FIG. 4-A

Ventral view of the right foot of an alligator.

In reptiles, as in amphibians, the hand is thick and meaty from intrinsic muscles. All muscles controlling the digits are of the brevis type, except the long flexor profundus,—the only forearm muscle which acts on the digits. Even it is still bipartite. In the gradation to mammals, the extensor brevis and flexor sublimis became long muscles by fusing end to end over the carpus with the forearm muscles and then separating from the carpus. The predominance of the intrinsic muscles in reptiles is shown in these sketches from the hand of an alligator.

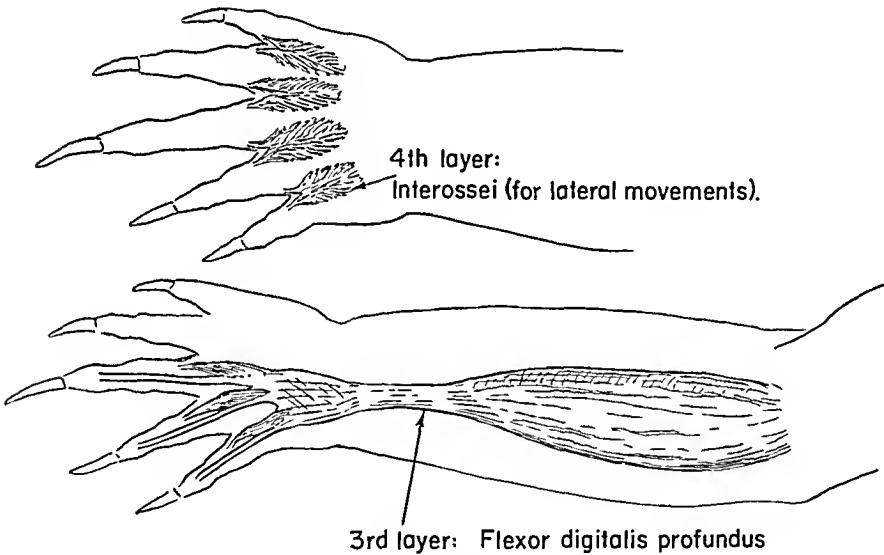


FIG. 4-B

Ventral view of the right front foot of an alligator.

fins", the forerunners of the lung fishes, which emerged from the water, evolved to amphibia, and developed lungs and feet for terrestrial existence.

The intrinsic muscles of the hand are found to be already highly developed in the amphibia, and in this class they have sole control of the digits. As yet no forearm muscles moved the digits, all extensors and flexors of the digits being of the "brevis" type, their origin not being above the carpus. The same high development of intrinsic muscles runs through reptilians, and even here the long flexor profundus is the only

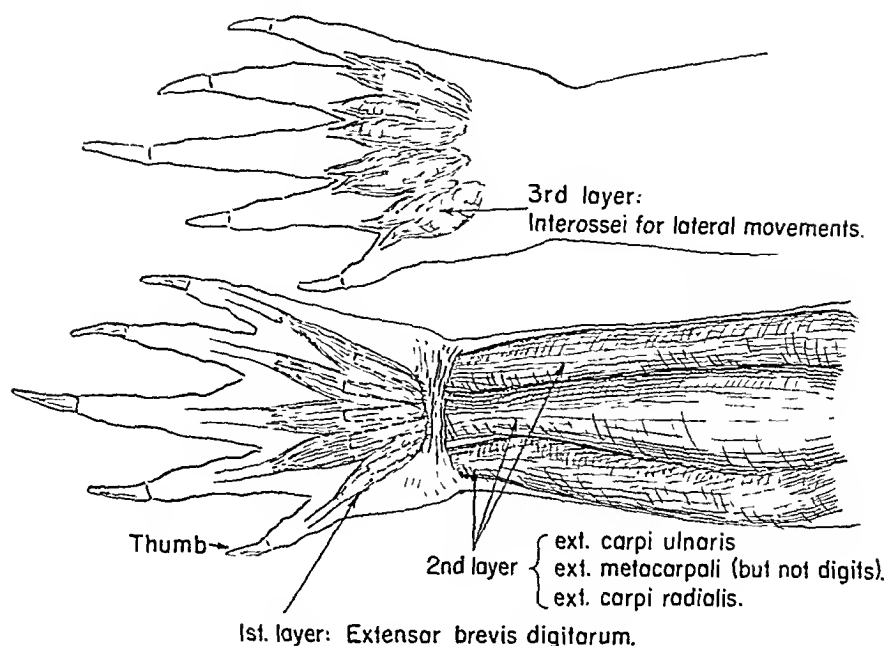


FIG. 4-C

Dorsal view of the right front foot of an alligator.

forearm muscle which has joined to the intrinsic muscles across the carpal ligament, so as to move the digits.

All other forearm muscles now did not insert below the carpus or metacarpals. It was an easy step, therefore, in the gradation to mammals, for this tendinous attachment or connection across the carpus merely to loosen from the carpus, with the result that the long muscle in the forearm was continuous with the one in the hand. This is apparently the development of the long extensors and long flexor sublimis in man, which now control our digits from the forearm. Recently the author had two patients who had two slips of the atavistic extensor brevis. In the human foot there is still an extensor brevis, and the flexor sublimis is a brevis.

In monkeys and higher apes the intrinsic muscles of the hand are well developed and their arrangement is so similar to that of man that the variations are small and rather exceptional. The four or five contrahentes of most mammals and monkeys, which are separated from the interossei by the deep branch of the ulnar nerve, have been reduced in man to just the adductor of the thumb.

Palmar interossei in most mammals are six or seven; and in primates, five or six; but in man there are only three, because four have fused with the dorsal interossei, thus accounting for the latter's double insertion.

In primates the palmar interossei and lumbricales insert in the lateral extension of the extensor tendons, and the dorsal interossei insert only on the phalanges. The axis of the interossei in man and most primates is the third digit, but in some prosimians it is the fourth.

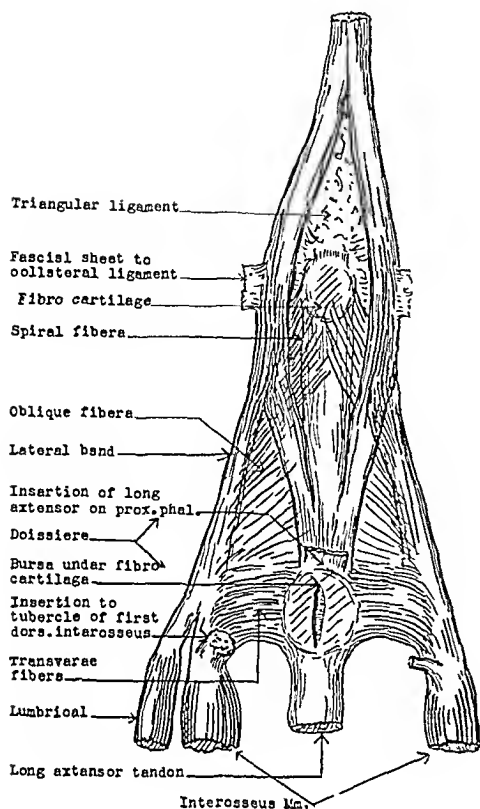


FIG. 5-A

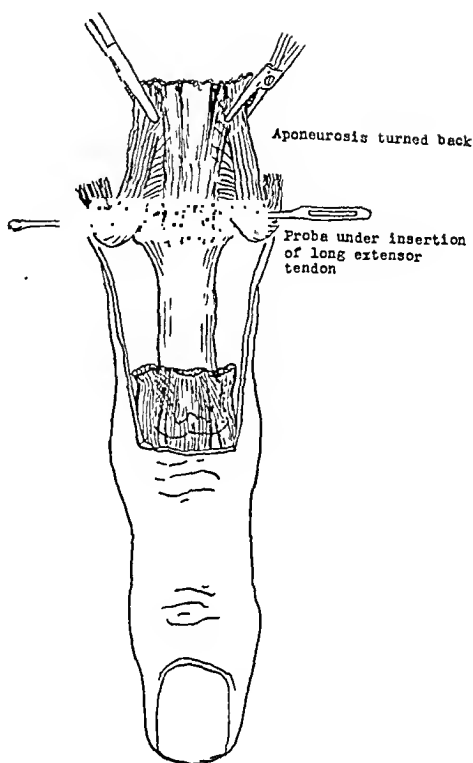


FIG. 5-B

Fig. 5-A: View of the under surface of the dorsal aponeurosis of the right index finger. This complicated aponeurosis coordinates the muscle action of the long extensor, the interossei, and the lumbricales.

Fig. 5-B: The *dossière* ("cloth over the back of a throne") is turned back to show the insertion in the proximal phalanx of the long extensor.

ANATOMY AND FUNCTION OF THE INTRINSIC MUSCLES

In the literature regarding the function of the intrinsic muscles controlling the fingers one finds such wide divergence of opinion that it is evident that the subject is still in the controversial stage. Textbooks of anatomy largely agree, but are incomplete, as they fail to consider synergic

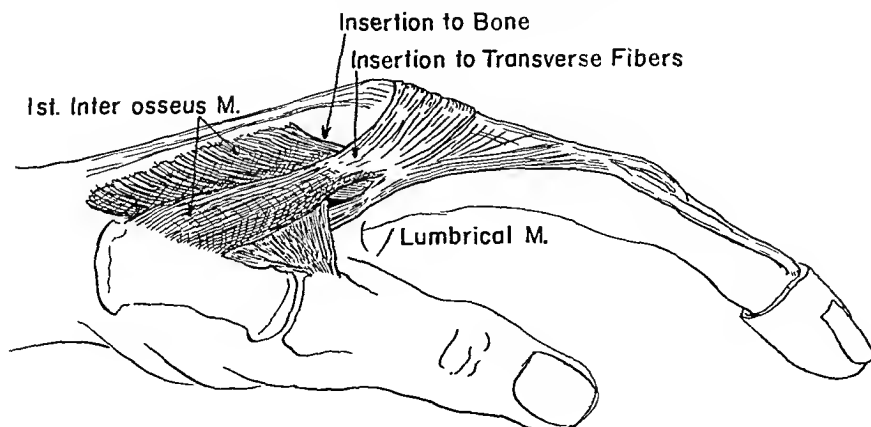


FIG. 6-A

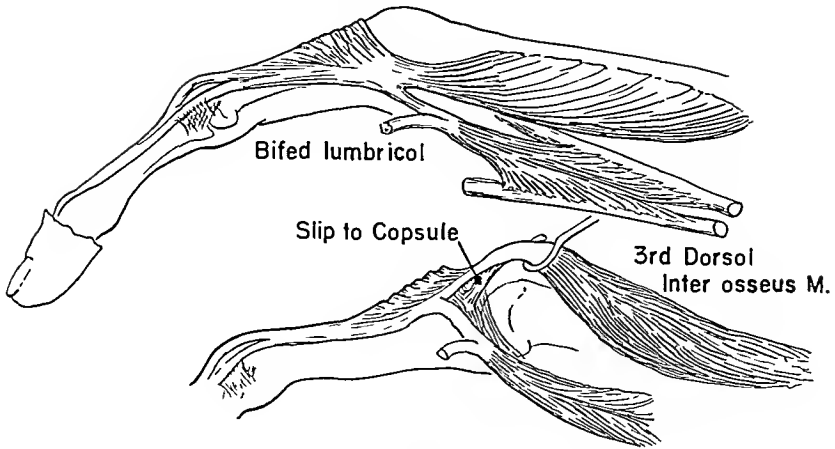


FIG. 6-B

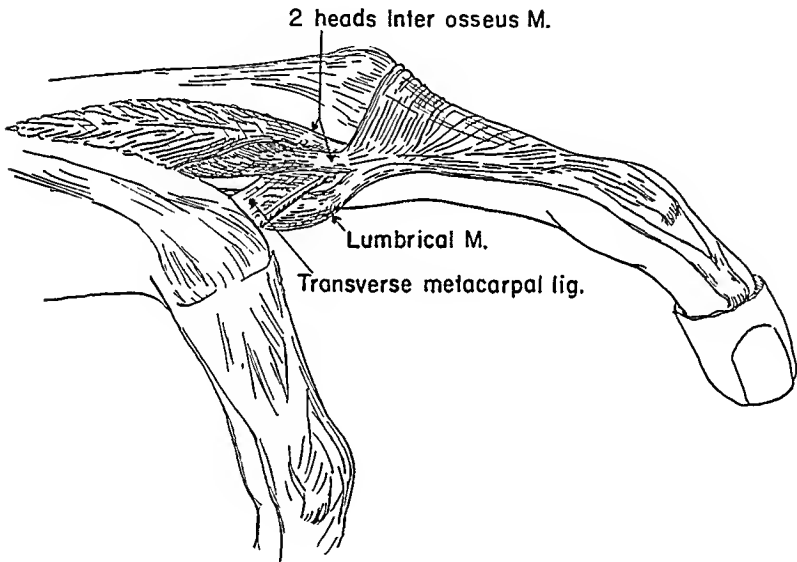


FIG. 6-C

Figs. 6-A, 6-B, 6-C, and 6-D show types of insertions. Lumbricales insert into the dorsal aponeurosis; interossei by several heads from fairly distinct muscle bellies insert variously into the phalangeal tubercle (Figs. 6-A, 6-B, 6-C, and 6-D), into the capsule of the joint (Fig. 6-B), and into the aponeurosis (Figs. 6-A, 6-B, and 6-C).

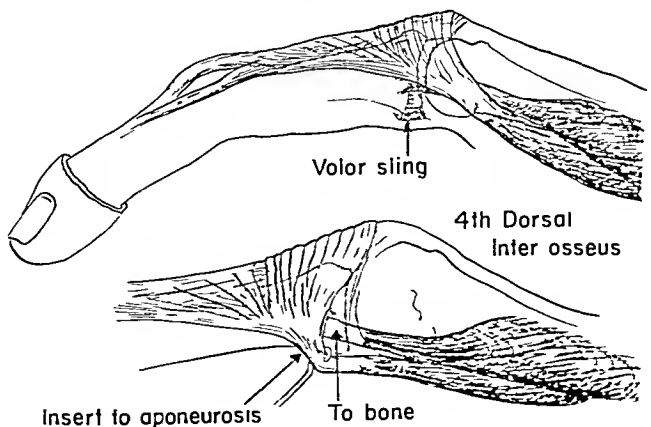


FIG. 6-D

action between the muscles; stabilization and coordination; and the conception that the lumbricales and interossei have a different action when the proximal finger joints are in their first half (45 degrees) of flexion than when they are in their second half, and a different function, depending on whether or not the extensor tendon stabilizes the proximal finger joints in extension. Embalmed cadavera are worthless for this study when compared with fresh hands. Recent advances are to be found in the contributions of Montant and Baumann, Hauck, Mason, Salsbury, and Hopper. In cooperation with L. D. Howard, Jr. and Donald R. Pratt, the author has dissected fresh eadavera, and made observations in the living during operations on the hands. He also has made direct examinations of normal and crippled hands in movement. After reviewing all available sources, the following conception of the anatomy and function has been reached.

The Dorsal Aponeurosis or Extensor Assembly

The thin sliding dorsal aponeurosis of a finger is a complicated mechanism which makes for ingenious coordination in action of the long extensors and flexors, and the lumbricales and interossei, so that the complete motion of flexion and extension of a finger is smoothly carried out; various muscles take over the action in turn, although each individual muscle has but a limited excursion of motion.

The tendons of the interossei and more laterally of the lumbricales fuse into the sides of this aponeurosis where they can be readily palpated in the finger. They first give off fibers transversely, as a sling over the dorsum of the proximal phalanx, for flexion of the proximal finger joint, and then continue on as the lateral band on each side of the finger to divide, the median fibers extending the middle joint and the lateral ones the distal.

The long extensor tendon, as it spreads into the aponeurosis, gives off first a central deep ribbon from its under surface to extend the proximal finger joint, and then divides into three slips,—the central one for the middle joint and the two lateral ones fusing with the lateral bands to extend the distal joint.

The Shift of the Aponeurotic Sleeve

At the base of the finger there is a remarkable mechanism which allows the conjoined tendons of the interossei and lumbricales either to flex the proximal finger joint or to extend the distal two finger joints according to whether the aponeurotic sleeve shifts distalward or proximalward, respectively. The transverse fibers, constituting the broad strap of dorsal aponeurosis across the back of the proximal phalanx, form the dorsal two-thirds of the sleeve. The ventral portion consists of a narrow band, blended with the joint capsule, and joining to the under surface of the aponeurosis laterally. The dorsal part of the sleeve, in company with the extensor tendon, can be passively made to shift on the phalanx longi-

tudinally fifteen millimeters, but the ventral portion only three millimeters. The dorsal portion, when in ordinary use, shifts on the phalanx about seven millimeters,—just enough for its thickened portion to lie across the phalanx or over the joint.

When the sleeve is distalward down the back of the phalanx, the intrinsic muscles can flex the proximal finger joints, but when the sleeve is drawn proximalward by the action of the long extensor tendon, the sleeve is over the proximal joint itself, thus robbing the intrinsic muscles of their leverage on the phalanx for use in flexing. It is like the shifting of gears. At the same time the long extensor tendon, in shifting the aponeurosis proximally, stabilizes the proximal joint in extension. The pull of the intrinsic muscles then is made automatically on the other branch of the Y of its tendon—the lateral band—and by it extends the distal two finger joints or imparts lateral motion. The transverse fiber



FIG. 7-A

Insertion of the lumbricalis and interosseus into the aponeurosis. A pull on either flexes the proximal joint by the transverse fibers which form a sling over the dorsum of the proximal phalanx.



FIG. 7-B

The lumbricalis is pulled.



FIG. 7-C

The interosseus is pulled.

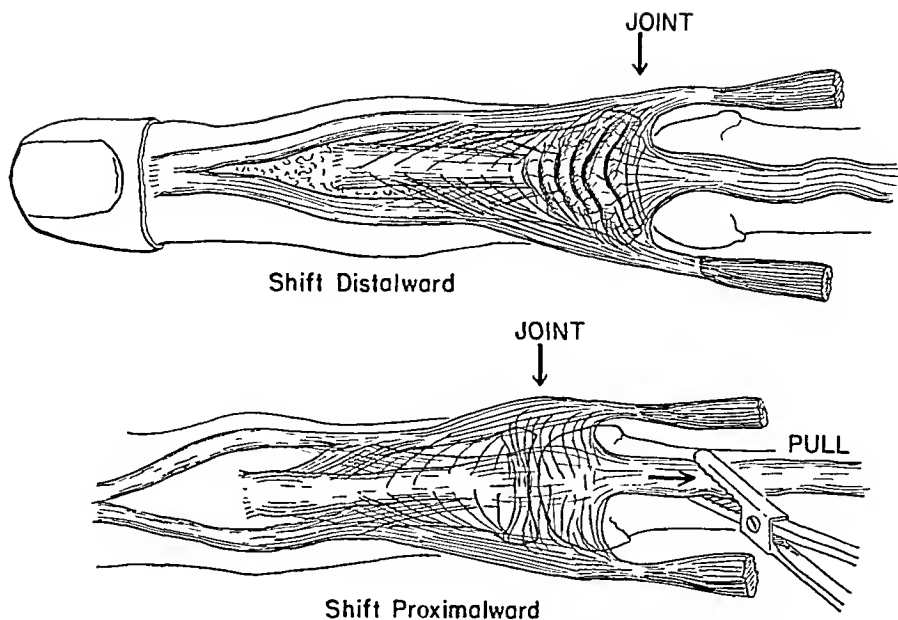


FIG. 8-A

The shift of the aponeurotic sleeve. Transverse fibers form a dorsal sling over the back of the proximal phalanx to flex the proximal joint, but when the extensor tendon, in stabilizing the proximal joint, shifts the sleeve backward until it is over the joint, the lumbricales and interossei pull on the lateral band to extend the distal two joints. (See Figs. 8-B and 8-C.)

branch of the Y slackens from the shift of the sleeve proximally. Therefore, when the long extensor stabilizes the proximal joint in extension, the intrinsic muscles extend the distal two joints. They flex the proximal joint only when the long extensor is relaxed.

Tendon Shift Volarward at Middle Finger Joint

The two lateral aponeurotic bands, which at the middle joint are in a rather dorsal position, are, as this joint flexes, seen to shift volarward one-fourth of the thickness of the finger, so as to short-cut this joint. This volar shift yields three millimeters of slack in the extensor tendon of the distal joint, which is important in repairing the insertion. Each main lateral band forks to spiral and lateral tendon slips to extend the middle and distal joints respectively, and has just eight to nine millimeters of motion to extend these two joints. On flexion of these joints, however, the lateral forks must short-cut across the middle joint, so that the above limited excursion of the main lateral band will allow both the middle and distal joints to be flexed at the same time. The shift conserves the longitudinal amplitude of the tendon bands and allows both joints to function.

Lumbricales

These four small muscles, named from their resemblance to a worm, have both origin and insertion on tendons of other muscles. Located on the radial sides of the digits, after arising by one or two heads from the profundus tendons, they lie between the tendons of the profundus and

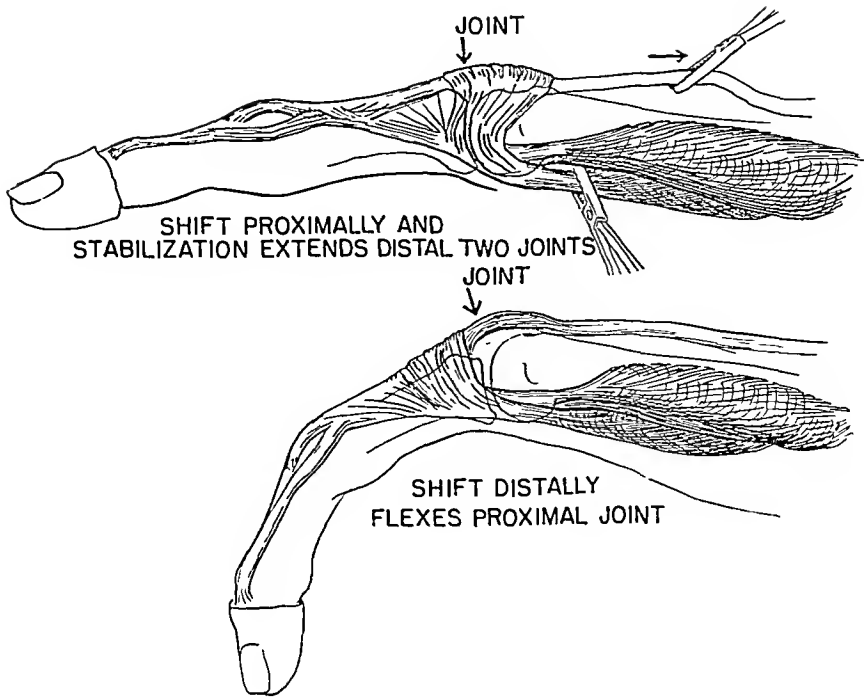


FIG. 8-B

sublimis, are flat, and each is intimately wrapped half around the sublimis tendon. They then diverge radialward from the sublimis and pass in front of the slippery flat transverse metacarpal ligament, which spans the distance between the heads of the metacarpals and lies in front of the interosseous spaces, separating the lumbricales from the interossei. The lumbricalis, in crossing the transverse metacarpal ligament, passes over the radial condyle of the metacarpal, and from there turns dorsalward to join the tendon of the interosseous just distal and lateral to that muscle, to form the outermost fibers of the lateral band or expansion of the dorsal aponeurosis, and also the

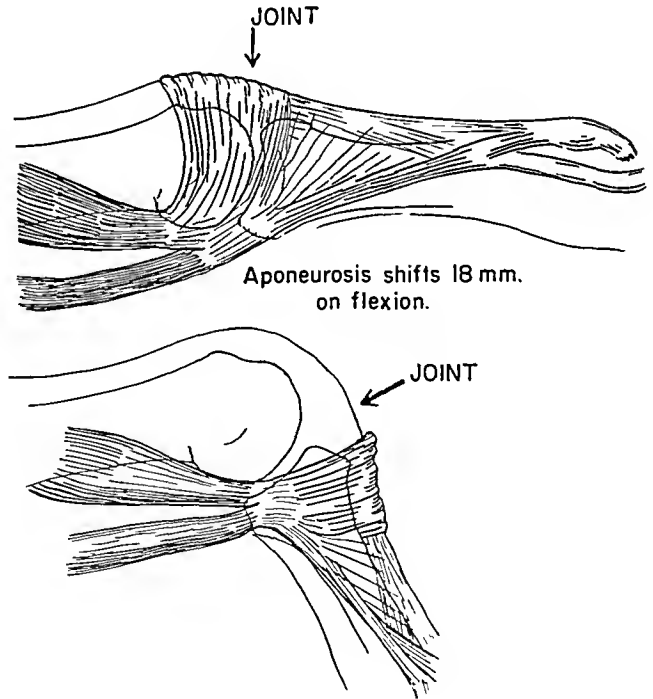


FIG. 8-C



FIG. 9-A

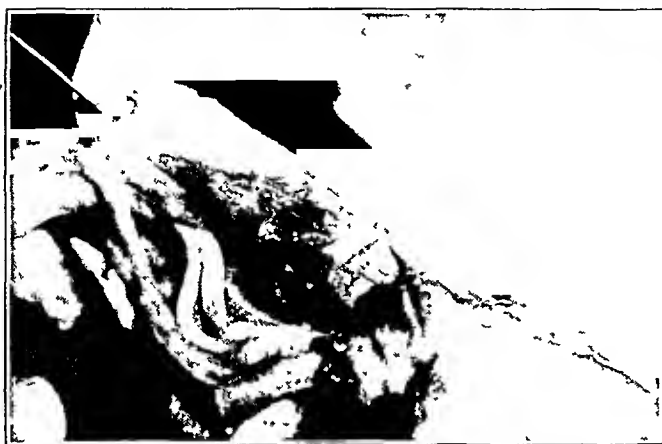


FIG. 9-B

transverse fibers which loop over the back of the phalanx.

In the turn dorsally, as it passes over the radial condyle of the metacarpal, the lumbricalis makes an angle of approach to the phalanx of 35 degrees for good flexion action.

When the long extensor tendon is taut, the lumbricalis extends the distal two finger joints and gives some radial lateral motion; but, when the long extensor tendon is slack, the lumbricalis flexes the proximal finger joint and nothing more. Lumbricalis action in ex-

tending the distal two finger joints is strong when the proximal joint is held fully extended, but lessens as this joint flexes through its first 45 degrees, or one-half of its range. Beyond this, lumbricalis action soon becomes nil, as this function is taken up by the long extensors.

The lumbricalis initiates flexion of the proximal finger joint, even when the latter is in hyperextension, and carries through its complete range of flexion. The long flexor tendons alone can also flex these joints strongly, as is seen in cases of median and ulnar palsy. The lumbricalis is dependent also on its origin from the flexor profundus tendon, and this must first be tense. A profundus tendon, also through the lumbricalis, flexes the proximal joint or aids in extending the distal two. In extending the fingers, the lumbricales aid, not only in extending the distal two joints, but also in drawing the profundi distalward to allow the fingers to extend freely.

Interossei

The four dorsal interossei abduct the fingers from the long finger as an axis, and the three palmar interossei adduct them toward the axis. The dorsal ones insert by separate slips to bone, capsule, and tendon, but the palmar ones insert mostly to tendon with an occasional slip to capsule. In man, most of the interossei have three different types of insertion: one

on the lateral tubercle of the phalanx, which is somewhat ventral to the mid-line; another by a small slip to the side of the joint capsule, which in turn is transmitted both dorsally, by some transverse fibers to the sling of the dorsal aponeurosis, and longitudinally, through the capsule to the side of the phalanx; and a third to the lateral band or expansion of the dorsal aponeurosis.

The first dorsal interosseus is unique in inserting into the lateral tubercle and into that part of the aponeurosis which transmits its pull to the transverse fibers only, but has practically no action of extension on the distal two joints. The interossei in the third

cleft, and occasionally in the second cleft, may be devoid of insertion on the tubercle, but they usually send a slip to the joint capsule as already explained.

In a cleft, a typical arrangement of the dorsal interosseus is to have two bellies more or less fused, each of which takes its origin from each of the contiguous metacarpals. The superficial one runs volarward, crossing either radialward or ulnarward over the deep one to insert deeply either to the tubercle or capsule of the joint. The deeper belly inclines dorsally and inserts into the lateral band, sending a small slip to the capsule. This separates somewhat the functions of these two muscle bellies,—the one to the bone flexing and giving lateral motion to the proximal joint; and the other, in addition to this, giving extension of the distal two joints.

The function of all the interossei is to flex the proximal finger joints when the long extensor tendon is slack. When the long extensor tendon



FIG 9-C



FIG. 9-D

Stabilization of the proximal joint in extension by the long extensor tendon pulls the aponeurotic sleeve proximally until it is over the joint (Fig 9-A). The intrinsic muscles then pull on the lateral band and extend the distal two joints (Fig. 9-D). A shift of the aponeurotic sleeve distalward changes their function to flexors of the proximal joint (Figs. 9-B and 9-C). In Figs. 9-A and 9-B a probe marks the joint, and a hemostat on the aponeurosis shows the shift.

stabilizes the proximal joint in extension by retracting the aponeurotic sleeve as previously described, the interossei furnish lateral motion to the fingers and, with the exception of the first dorsal one, also extend the distal two finger joints. The interossei thus have the same functions as the lumbricales, but they are stronger in all the motions. The lumbricales give weak lateral movement, but have the advantage of angle of approach in starting flexion. They also have a longer range of movement, counting the additional help of the flexor profundus.

The interossei give lateral motion by any of their insertions,—band, capsule, or tubercle; but that from the latter is slightly stronger. The interossei initiate flexion of the proximal finger joints all the way from the straight position to that of full flexion and, along with the lumbricales, add considerable strength to the grip. Weakness of grip is marked in ulnar paralysis.

Extension of the distal two finger joints by the interossei and lumbricales is strong when the proximal finger joints are straight or hyperextended, but, as they flex to near 45 degrees, the action of the interossei and lumbricales becomes less, and beyond 45 degrees it becomes negligible. During flexion of the proximal joint, the long extensor takes on more and more the duty of extending the distal two joints and its maximum action is reached when the proximal joint is three-fourths flexed; from that point it recedes, especially in the distal joint.



FIG. 10-A



FIG. 10-B

When the proximal joint is stabilized in extension by the long extensor tendon, the lumbricales and interossei impart lateral motion to the finger. In both Figs. 10-A and 10-B the long extensor is taut; in Fig. 10-A, the interosseus is relaxed and in Fig. 10-B it is pulled upon, imparting lateral motion.

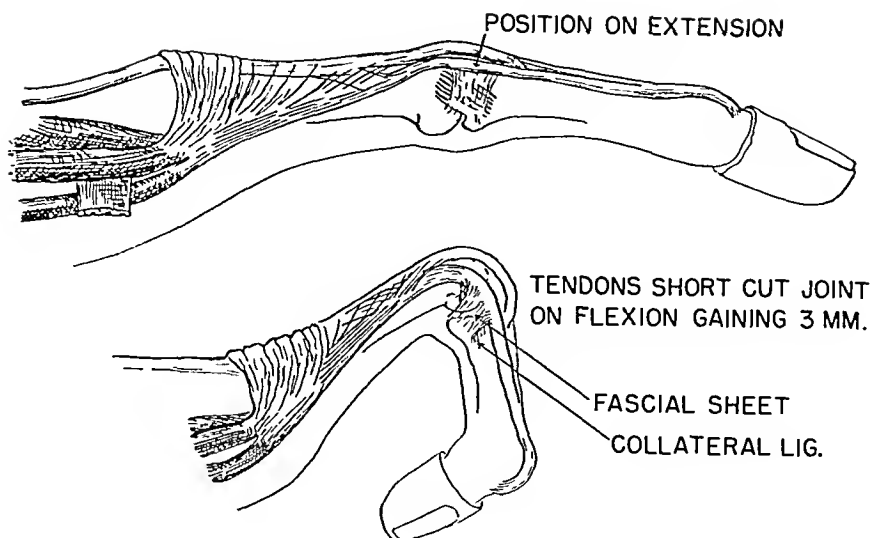


FIG. 11

The volar shift of the two lateral bands at the middle joint. On flexion the two lateral sheets automatically displace the tendons, so that they short-cut across the joint.

Long Extensor Tendon of the Finger

The long extensor tendon is synergic in action with the intrinsic muscles. Alone it extends the proximal finger joints to hyperextension. Extension of the distal two finger joints is by the intrinsic muscles or the long extensor, depending on the degree of flexion of the proximal finger joint as has been stated.

The long extensor tendon has the second important function of stabilizing the proximal finger joint in extension, so that only then can the intrinsic muscles extend the distal two finger joints and impart lateral motion to the finger.

The Adductors of the Thumb

In ulnar-nerve paralysis of the adductors of the thumb, two signs are of particular interest. The patient cannot make a perfect O with the thumb and index finger, and the pinch between them is weak. When he attempts to do this, the metacarpophalangeal joint of the thumb drops into hyperextension. The same deformity is seen from loss of the abductor pollicis tendon. In the former case it is due to lack of flexion effect on the metacarpophalangeal joint, and in the latter to loss of ability to stabilize the metacarpal in extension. Not all cases of ulnar paralysis show this, as in some the median motor nerve supply extends far enough ulnarward to flex the metacarpophalangeal joint.

Another sign of adductor paralysis is inability to scrape the extended thumb across the palm and bases of the fingers to the ulnar side of the hand. Instead the thumb comes forward from the palm at the radial border of the index finger.



FIG. 12-A

Shows the volar shift of the lateral bands on flexing the middle joint.



FIG. 12-B

Shows the resumption of the dorsal position of the bands on extension. A probe passes under the lateral sheet, which is attached to the collateral ligament and middle phalanx, and automatically causes the volar shift.

The abductor minimi digiti inserts on the lateral tubercle of the proximal phalanx and the joint capsule, and sends out transverse fibers and a lateral band like that of the interossei. It does not, however, extend the distal two joints. It flexes the proximal joint when the long extensor tendon is slack, and abducts it from the hand when the long extensor stabilizes the proximal joint in extension. The opponens minimi digiti opposes the little finger to some extent, similar to the opposition in the thumb. The thenar and hypothenar muscles, with the exception of

the two abductors, maintain the carpal arches.

Carpal and Metacarpal Arches

The arching at the carpus and metacarpal heads is essential for grasping small round objects. It results in a tipping of the axes of the proximal finger joints, which makes the fingers converge on flexion and spread on extension, and greatly helps opposition of both the thumb and the little finger. The arches also give strength and resiliency when pressing with the hand. Normally, in opposing the thumb and little finger, the palm is cupped and the curve of the metacarpal arch is increased.

Maintenance of these arches is by the thenar and hypothenar muscles which span from the carpus to the two outside rays. Thus, in combined median and ulnar paralysis, the hand is flat and the thumb is at the side.

Movements of the Hand in General

Lateral movement of the fingers is possible only when the proximal joints are straight or nearly so. Absence of side motion when in flexion is desirable as it gives firmness to the grasp. When the joint is straight,

the proximal phalanx has free lateral motion on the narrow vertical saddle-like end of the metacarpal, and the collateral ligaments are loose. In flexion the phalanx slides volarward on an ever-widening articular surface. The collateral ligaments tighten, and, in full flexion, the flat end of the phalanx rests on the broad flat volar aspect of the head of the metacarpal, preventing all lateral movement.

One should not mistake the spread of the fingers, when in full extension by the long extensors, for action of intrinsic muscles, because this is due in part to the curve of the metacarpal arch, and, to some extent also, to muscle tension, aligning the phalanges with the metacarpals which diverge a little. Lateral movement by intrinsic muscles is possible only when the proximal joints are stabilized in extension by the long extensors. It should be tested by the individual lateral motion of the fingers when the proximal joints are in slight flexion. Strength and width of spread show it only when compared with that in the other hand.

The action of tendons and muscles in the hand can readily be checked by feeling one's own hand when the fingers are working against resistance. Thus one feels lateral bands, aponeurotic and volar shifts, long extensor tendons, lumbricales and profundus tendons in the various movements.

In normal muscle balance between the long extensors, long flexors, and the intrinsic muscles, the hand assumes a position with the wrist slightly dorsi and ulnar flexed, the fingers partially flexed in all joints, with increasing degree of flexion from the index to the little finger. The thumb is forward from the hand, partly flexed and in mild opposition, and the normal arches are present. In this position of function, the mechanics of the hand are at their best.

Every motion of the hand is done with balance of muscle pull or coordination between several muscles in synergic action. It has been seen how the work of extending a finger from full flexion falls first on the long extensor, but, as the extension progresses, is gradually taken over by the intrinsic muscles, the long extensor having changed to an extensor and stabilizer of the proximal joint. Practically it can be considered that the intrinsic muscles extend the distal two joints in the first half, or 45 degrees, of flexion of the proximal joint, and that the long extensor tendon extends them when the proximal joint is in the last half of the range of flexion, though, of course, transmission of function is gradual.

The separate functions of the intrinsic muscles are dependent on the stabilization of the proximal finger joints in extension by the long extensors. Without this they flex the proximal joints; with it they extend the distal two joints; and by pulling alternately they can give lateral motion.

The mechanism of volar shift of the two lateral extensor bands at the middle joint is effective in conserving the limited amplitude of the various muscles. The whole arrangement in the finger shows perfect synchronism, each muscle and tendon doing its part, conserving its limited amplitude of motion, and so relaying its action that, by coordination with each other, the complete motion is carried out.

CLINICAL TYPES OF LOSS OF INTRINSIC MUSCLES OF HAND

The long flexors can completely flex each of the three finger joints, but without the intrinsic hand muscles the finger tips in full flexion usually touch only the bases of the fingers, and are not flexed into the palm, the proximal joint remaining straight. There seems to be not enough amplitude of motion of the long flexor tendons to flex the proximal joints at the same time; help from the lumbricales and interossei is needed. Also, when the proximal joints are partially flexed by the long flexors, the distal two joints cannot be extended at the same time, as again the

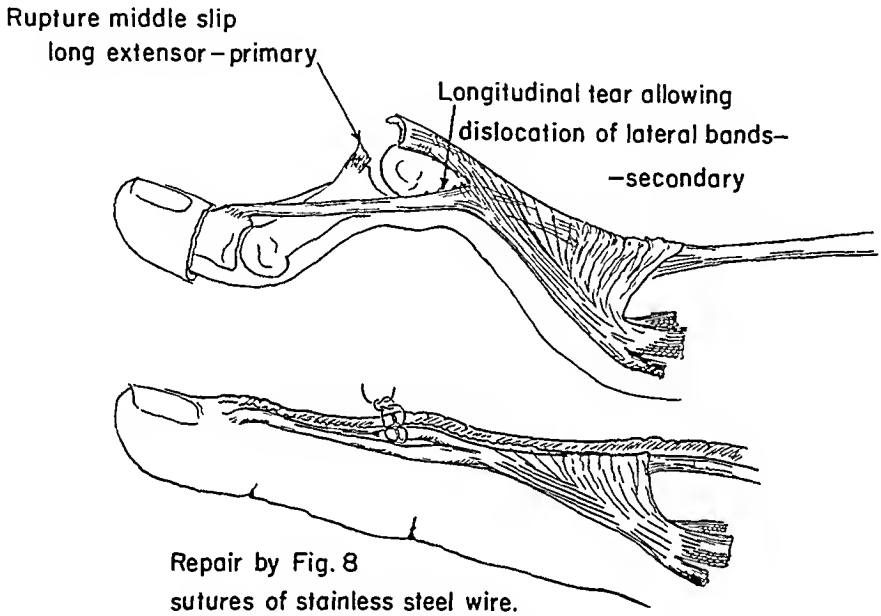


FIG. 13

The "*boutonnière*" deformity (top) is caused by rupture of the central extensor tendon slip at the middle joint and a subsequent tear of the aponeurosis. The lateral bands then flex the middle joint and extend the distal joint.

A simple figure-of-eight removable stitch of stainless-steel wire, together with splinting, is sufficient to cure a recent case. In a long-standing case, the slit also should be closed by a removable figure-of-eight suture through the skin and tendon.

intrinsic muscles are needed. Integrity of carpal and metacarpal arches and opposition of the thumb and little finger are wholly dependent on the thenar and hypothenar muscles with the negligible help of the palmaris longus. If the adductors of the thumb are not functioning, the thumb loses part of its range of motion across the hand and its force in adducting toward the hand. When lateral motion of a digit is lost, such as abduction of the index finger, the finger inclines ulnarward which upsets the mechanics for its good function.

When such imbalance remains, the unopposed strong muscles increase the deformity until it is structural—as is seen in long-standing cases of ulnar, or ulnar plus median, paralysis—necessitating correction of position before restoring muscle balance.

In ulnar paralysis, when repair of the nerve is no longer possible, there is need for restoration of carpal and metacarpal arches and of ability to adduct the thumb. Also the muscle balance should be restored to the little and ring fingers.

In combined ulnar and median paralysis, when it is not reparable by nerve suture, there is greater need for restoring carpal and metacarpal arches; all fingers are clawed and need return of muscle balance. The thumb is useless at the side of the hand and needs opposition and adduction. In poliomyelitis, the intrinsic muscles are often selectively paralyzed.

In the claw hand of Volkmann's ischaemic paralysis, the imbalance is from contracture overpull of the long flexors and also from a degree of paralysis of the intrinsic muscles. The latter is due to the ulnar nerve being affected by the ischaemia when in the fascial enclosure of the forearm, and by the subsequent strangling by cicatrix.

Hands that have been ravaged by infection show the same type of deformity that is seen in ulnar and median nerve paralysis (fingers clawed, hand flat, and thumb at the side), because during the infection the intrinsic muscles were paralyzed by being bathed in pus. Moreover, infection travels up the forearm along the course of the two nerves. Cicatricial strangling of muscles and nerves follows, and thus fixes the deformity of imbalance. Other cases for repair are those caused by direct injuries which destroy some of the intrinsic muscles of the hand or leave them immobile in cicatrix.

Rupture of the middle extensor slip near its insertion to the base of the middle phalanx results in the deformity of hyperextension of the proximal joint, flexion of the middle joint, and hyperextension of the distal joint. This "*boutonnière*" deformity has been ascribed to a central longitudinal tear in the extensor tendon, which allows the two lateral slips to separate and move volarward, so that the joint herniates through the slit. The lateral slips then act as flexors for the middle joint, thus increasing the deformity. This, however, is the result of first severing the middle slip. Then as the joint is flexed, the buttonhole tear occurs secondarily.

Two other deformities are common in fingers. One is drop-finger at the distal joint, due to bone evulsion or rupture of the extensor tendon insertion. This may be considered the insertion of the intrinsic muscles when the proximal joint is in extension, and of the long extensor tendon when it is well flexed.

Hyperextension of the middle joint with flexion of the distal joint occurs on rupture of the anterior part of the capsule of the middle joint. It also exists normally in some people, and in these the long extensor is seen to stand out as a strong double cord running to the middle joint and overextending it. The flexor profundus then automatically draws the distal joint into flexion. This occurs in double-jointed people with laxness of the anterior part of the capsule of the middle joint.

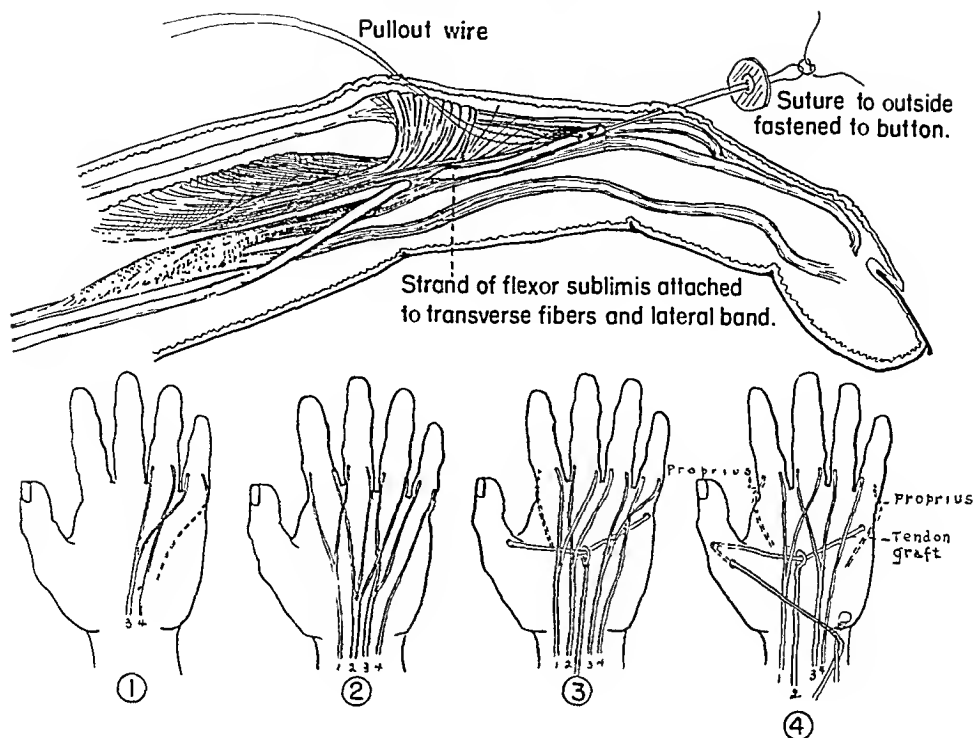


FIG. 14

In the operation to restore muscle balance in a finger after loss of the intrinsic muscles, the sublimis tendon, or a strip thereof, follows a straight course through the lumbricalis canal and is inserted into the transverse fibers and lateral band of the dorsal aponeurosis, by a simple stitch of stainless-steel wire No. 35 which passes on out through the skin to a button. The wire is removed by the pull-out wire in three weeks. The tendon and the dorsal surface of the lateral band have been scraped for better attachment. (1), (2), (3), and (4) show combinations for placing tendons, so that the lateral motion supplied by each single tendon to several fingers will be in the same direction. Small numbers indicate which sublimis tendon is used.

In (3) is shown a combination with a tendon-T operation for adduction of the thumb and restoration of the arches, and also an index long extensor used for abduction of the index finger. In (4) is shown the same with the addition of a tendon for opposition of the thumb and another for abduction of the little finger.

TREATMENT

Nerve suture for ulnar or median paralysis should be done if it is mechanically possible, and if the interval since the paralysis has not been so long that fibrous degeneration of muscle has been established to the point where even the reaction of degeneration is no longer present. The tiny motor branches of the ulnar and median nerves in the palm are not too small to suture with good results, as shown by eighteen personal cases. Operations for tendon transfer in such paralysis are only for patients in whom the nerve injury is irreparable. If the deformity is easily corrected passively, the nerve and muscles alone are to blame; but, if firm structural changes have set in, these must first be corrected by the usual methods of mild prolonged tension, capsulotomies, osteotomies, etc. Postinfection cases are not suitable for tendon transfer in a finger unless the tissues are flexible or unless by excision of cicatrix they can be made so.

The very thin and complicated dorsal aponeurosis is too delicate for the usual surgical repair by suture, and too readily adheres to the bone

beneath. Therefore, the author has been using the thinnest and least irritating suture,—stainless-steel wire. The simplest stitch is used and placed so that it can be removed in three weeks,—that is, withdrawn by a pull-out wire.

Sir Harold Stiles, in 1922, described an operation for claw-finger. He detached the flexor sublimis tendon from its insertion in the finger, split it, bringing each end around to the back of the finger and then suturing each to the extensor tendon with linen. He stated that he did not know the result as he was, due to the war, unable to follow the patients. The author tried this operation twice, but each time it resulted in failure, as the finger had less movement than before. The delicate parts of the extensor tendon were not differentiated and all became bound firmly. The suturing should not have been to the extensor tendon. Also, the sublimis tendon had a tortuous course and penetrated through an annular band of fascia, which favored adhesions. This operation does not consider the action on the transverse fibers and lateral band or the shift of the aponeurotic sleeve.

The following is a new technique which is planned to give the least possible adhesions, a straight course for the tendon, good leverage, and the normal angle of approach. The tendon juncture is made on the dorsal surface of the transverse fibers and the lateral band, where adhesions are not detrimental. The gliding surface of the lateral band and dorsal aponeurosis is not disturbed. There is no permanent suture material left in the wound.

In this operation the flexor sublimis tendons are detached from their insertions, withdrawn from the palm, split, and then passed down the lumbrical canals to be attached to the transverse fibers and lateral bands in the finger. The object is to restore muscle balance, to furnish extension to the distal two joints, to help flexion of the proximal joints, and to furnish lateral motion to the fingers. The middle joint is already in flexion deformity, so the loss of the sublimis is of less importance.

Through a mid-lateral incision in the finger, the length of the proximal segment, the sublimis tendon is cut off through a nick in the sheath opposite the joint. If cut too long, the stumps attach, making flexion contracture of the middle joint. The tendon is withdrawn enough to slit it an inch or more, and then, through an L-shaped incision in the palm paralleling the creases, is withdrawn and split its length. If desired, it may be split in four with the back of a scalpel blade.

A fine No. 35 stainless-steel wire with a needle on each end is sewed into the end of a strand of sublimis tendon, threading each needle back and forth twice through the tendon until the end of the tendon is reached, where the two ends of the wire will emerge. A pull-out wire is placed through the loop of the wire for later removal. The two end wires are threaded on one needle, which is passed down the lumbrical canal and on out the lateral incision in the finger and over the lateral band, the top surface of which is scraped to receive it. The wires are then passed on

across the finger and out through the dorsal skin, where they are fastened to a button. The two ends of the pull-out wire are threaded on one needle and passed out through the skin proximally, where they are left for use in pulling out the stitch three weeks later. To remove the stitch the ends are cut off close to the skin and the stitch is withdrawn backward by the pull-out wire.

From the one lumbrical canal two tendon strands will pass one to each side of the cleft. The bed of the tendon is in soft gliding tissue all the way. The tendon should be threaded in and out the aponeurosis once as it passes the transverse fibers, so that, by taking advantage of the gliding aponeurosis, it will both flex the proximal finger joint and extend the distal two. Attachment to the transverse fibers and lateral band will result if their contiguous surfaces are well scraped and they lie in close apposition while healing. The tendon will be found to be the right length, reaching to within a centimeter of the middle joint on the dorsum of the finger.

The split strands from any one tendon should go either all to the radial sides of the fingers or all to the ulnar sides, so that lateral motion will be possible, one tendon pulling two or more fingers radialward and another tendon ulnarward.

One must plan to use to the best advantage whatever tendons are available. If all sublimi, except that of the little finger which is tiny, are split in two, there are seven strands; some can be subdivided. Each finger should have at least one strand, so that the distal two joints will extend and the proximal joint will flex well. To the index and little fingers the tendon should be placed on the radial and ulnar sides, respectively, for abduction from the hand. Their respective extensor proprius tendons can be used for this purpose if desired. The sublimis tendon to the index finger should go to the lateral band instead of to the tubercle, if it is expected to extend the distal two joints. It is advisable to transfer tendons to each side of each finger, but one must figure to have enough tendons for also furnishing adduction and perhaps opposition to the thumb. Besides the sublimus tendons there are available the two extensor proprius tendons, the palmaris longus, and even free tendon grafts from the palmaris longus or extensors of the small toes. The hand and fingers are splinted for three weeks with the wrist in flexion. This is followed by light motion for another week and the refraining from hard work for two months.

Operations to Restore Adduction to the Thumb and Curvature to the Carpal and Metacarpal Arches

Two methods are available,—the tendon-loop operation and the tendon-T operation.

In the tendon-loop operation, to furnish adduction to the thumb, the tendon of the extensor digitorum communis to the index finger is detached, just before it spreads out over the proximal joint of the index finger, and is withdrawn at the base of the back of the hand. It is elongated, by

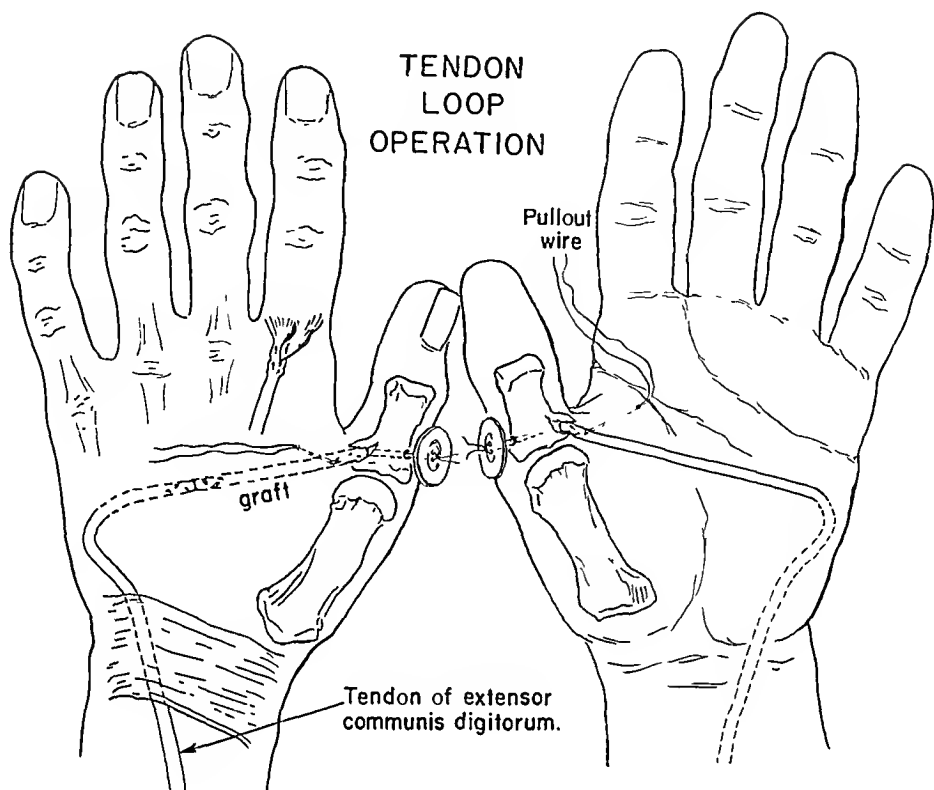


FIG. 15

In the tendon-loop operation to restore adduction to the thumb, the extensor communis tendon from the index finger is prolonged with a tendon graft, and then passed subcutaneously around the ulnar border of the hand and across the palm under the flexor tendons to act as an adductor of the thumb. Attachment to the thumb is by fine stainless-steel wire through a drill hole to a button outside the skin. A flake of bone is chipped up at the insertion. A pull-out wire is placed so that the stitch may be removed in three weeks. The stump of the extensor communis of the index finger is attached to the extensor indicis proprius to prevent rotation deformity.

adding a free tendon graft from the palmaris longus or other tendon, and is passed subcutaneously around the ulnar border of the hand, then across the palm deep to the flexor tendons, to be inserted on the ulnar side of the base of the proximal phalanx of the thumb.

The communis tendon is selected instead of the proprius, because its muscle is stronger. It is essential to attach its stump, where cut off, to the proprius tendon, so that the latter will pull symmetrically on the tendinous cap of the joint; otherwise the index finger will show deformity of rotation and adduction. A short transverse incision is used there and also on the dorsum of the hand at the distal edge of the annular ligament. The incisions at the ulnar border of the hand and ulnar side of the thumb are mid-lateral.

In passing the tendon around the ulnar side of the hand, it was found best not to pass it under the hypothenar muscles, because their perimysium adhered to it. A simple way of attaching the tendon to the phalanx of the thumb is to place a wire stitch in the tendon, as described

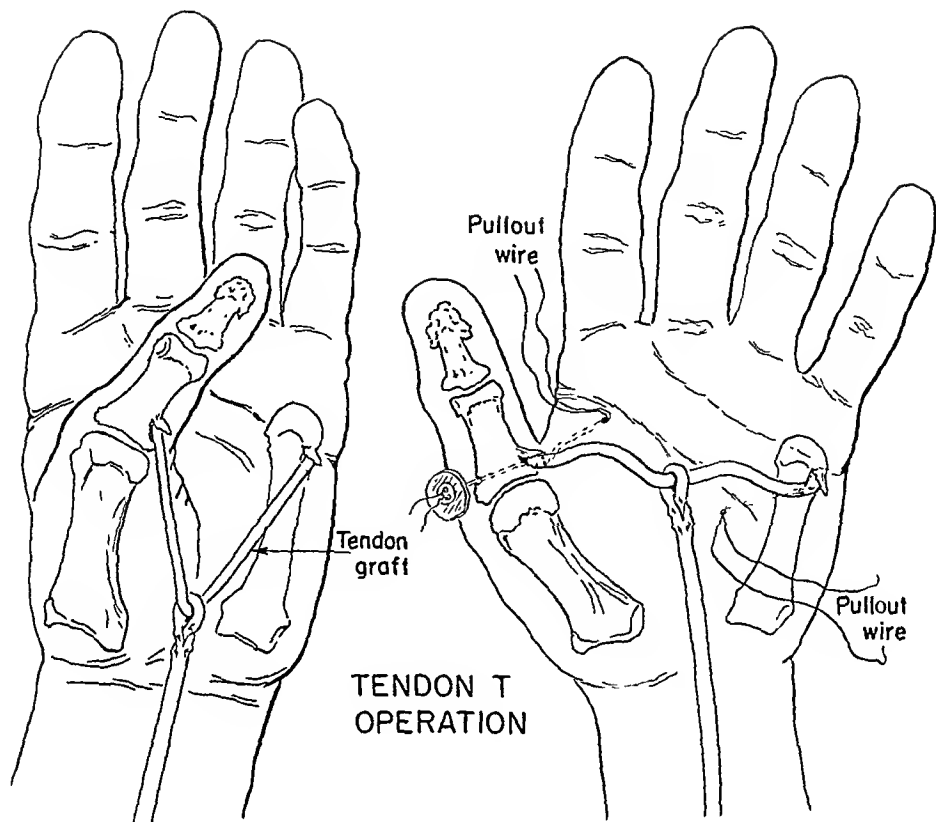


FIG. 16

In the tendon-T operation to restore adduction to the thumb and curvature to carpal and metacarpal arches, a tendon graft spans the distance between the little finger metacarpal and the adductor insertion in the proximal phalanx of the thumb. A long flexor tendon of the forearm (a sublimis or the palmaris longus prolonged by a strip of its palmar fascia) is looped over its center to form the T. This, when in action, changes to a Y adducting the thumb and curving the arches. Attachments to bone are made as in Fig. 15.

in the operation for claw-finger. A thin flake of bone is chipped up, and under this the wires on a single straight needle are passed through a drill hole through the bone and out the skin on the opposite side of the thumb, where they are threaded through the holes of a button and tied. The pull-out wire is also brought out through the skin proximally, so that the stitch wire may be removed in three weeks.

The tendon-T operation gives strong adduction to the thumb and little finger and cups the hand, restoring carpal and metacarpal arches. It consists of one free tendon graft spanning across the palm behind the flexor tendons from the base of the proximal phalanx of the thumb to the neck of the metacarpal of the little finger. One of the long flexor tendons of the forearm, such as a sublimis, is attached by a loop to the center of the cross tendon, thus forming a T. On flexion of the muscle, the T is drawn to a Y, drawing the thumb and fifth metacarpal toward each other and restoring the arches. The cross member lies in soft movable tissue back of the profundus tendons and can be drawn proximalward without resistance. It does not press or pull against the deep branch of the ulnar

nerve which is behind it. The cross part of the T comes in full flexion as far proximally as the carpus, and the angle of the Y thus formed is then 40 degrees.

The fifth metacarpal is exposed in its ulnar volar aspect. One end of the cross tendon is fastened to it under a chipped-up flake of bone, as described for the thumb in the tendon-loop operation, the button resting on the skin of the back of the hand over the dorsoradial aspect of the fifth metacarpal, where the wires come through. The palm is opened by a small L-shaped incision paralleling the creases. The tendon is passed across through the palm behind the flexor tendons, and is made to emerge through a small lateral incision over the ulnar aspect of the base of the proximal phalanx of the thumb. Here it is similarly attached by passing the wires through the phalanx and thumb to a button on the opposite side, and placing a pull-out wire. The tendon should be slack when the hand is fully spread, as grafts shrink a little. The long flexor tendon is then looped around the center of the cross tendon, embedding it in and suturing it to itself; one stitch is placed to keep it from sliding along the cross tendon. In place of the sublimis tendon, the palmaris longus tendon with its prolongation of palmar fascia, or any other flexor tendon that is available, may be used.

Operation to Furnish Abduction to the Index Finger

Frequently from local injury there is loss of the first dorsal interosseus muscle with adduction deformity of the index finger, which greatly interferes with its function. In such a case the extensor indicis proprius is detached near its insertion and, after it has been lengthened with a short tendon graft, it is inserted into the lateral tubercle on the radial side of the proximal phalanx of the index finger. The stub of the insertion of the proprius should then be sutured to the extensor communis tendon of the index finger, so that the latter will pull symmetrically on the tendinous cap over the proximal joint of the index finger. In ulnar paralysis only a little adduction of the index finger occurs, as there is no functioning muscle to cause the deformity.

In case of loss of the index finger and its metacarpal, the long finger may go into adduction and need this operation. Similarly, abduction can be supplied to the little finger after loss of its abductor by using the extensor digiti quinti proprius.

If an interosseus tendon is merely adherent to the bone from injury, a piece of deep fascia, if placed between tendon and bone with its gliding side outward, will allow movement. Cicatrix, if present over the site, should be replaced with a good flap of skin.

Repair of Drop-Finger

If splint treatment is commenced within a week and maintained for five weeks, operation can usually be avoided. The middle finger joint should be in flexion and the distal joint in extension, as this is the effective

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THE INFLUENCE OF ESTROGENS ON THE SHAPE OF LONG BONES

BY JOHN L. BREMER, M.D., BOSTON, MASSACHUSETTS

The growth or enlargement of long bones is always accompanied by a certain amount of bone destruction. Duhamel, in 1739, proved that the expansion of the marrow cavity during the widening of the shaft was due, not to the interstitial growth of the cortex, but to external apposition and internal dissolution, for metal rings placed around the periosteum in young pigeons were later recovered from the marrow cavity. A few years later John Hunter pointed out that the slenderness of the shaft of a bone, as compared with the breadth of the epiphysis from which it developed, could only be explained by the local resorption of the bone at the outer surface of the subepiphyseal region during growth. More than a century later Kölliker, in 1873, charted the location of this active resorption on the surfaces of many bones at various ages, as marked by the presence of Howship's lacunae and osteoclasts. The present paper deals with a further analysis of this subepiphyseal resorption of the surface of the diaphysis, to which in great part is due the adult shape of long bones, and suggests probable causes for the phenomenon.

The external or surface resorption is a much more rapid, vigorous process than that entailed in the widening of the marrow cavity. In the latter case, the depth of the erosion, as represented by the increase in the diameter of the cavity, may be measured by a few millimeters in a score or so of years. The external resorption or etching, if properly analyzed, is relatively much more extensive, for the erosion does not proceed inward toward the bone center, but in a linear, axial direction, and is measured by the increasing length of the bone. This is shown by study of the subepiphyseal region where the etching is going on (Fig. 1-1). As is well known, the cartilage cells at the epiphyseal line multiply, become arranged in vertical rows, and degenerate. Their lacunae enlarge at the expense of the cartilage matrix and run together, until only irregular spicules or trabeculae remain, which become coated by bone matrix by the entering periosteal tissue. It is these vertically oriented bone trabeculae at certain surfaces of the bone circumference that undergo resorption at their free tips, so that, as they elongate at one end at the expense of the cartilage, they are curtailed at the other or proximal end by destruction of their bone matrix. The destruction is most active at the periphery of the bone, for the trabeculae are successively longer toward the center of the shaft, their tips forming a smoothly sweeping curve, until a region is reached where bone destruction is absent and the trabeculae become incorporated in the shaft. The general effect is noticed as the undercutting of the epiphysis and as the local erosion of the shaft, which thus becomes more slender, though again by a matter of only a few millimeters; the actual

bone destruction is at right angles to this apparent direction, and is as rapid as the epiphyseal bone growth, which may amount to many centimeters during the growth period.

Histologically the changes accompanying the slow form of bone destruction are quite inconspicuous, but in the more vigorous type the cellular picture is characteristic. This has been given elsewhere⁴, where it was pointed out that the erosion of the trabeculae and the coincident inrush of young connective tissue into the enlarged primary marrow spaces are so similar to the changes found in the pathological entity known as osteitis fibrosa, that one may consider them as a minimal stage of this disease. Conversely, since this etching or undercutting is normally present in growing bones, one is forced to the conclusion that this form of osteitis is not due to an abnormal process, but merely to the abnormal increase of a process, itself normal to a minute degree during bone growth, and that the causative factor in the undercutting is probably the same as that underlying the disease.

Osteitis fibrosa, with the increase of serum calcium which accompanies it in its well-developed form but is not measurable in its early stages, is now known to result from hyperparathyroidism. Of this many clinical observations and the experimental production of the typical bone lesions in animals⁵ have supplied sufficient proof. The parathyroid glands are commonly spoken of rather vaguely as the "regulators" of calcium storage in the bone, and, by implication, also of the extent or severity of the destructive process which sets the calcium free. The idea of regulation connotes either the ability to measure the supply of the activating principle—whether it is to be more or less—or the control afforded by two opposing principles, working in this case for bone deposition and bone resorption respectively. For either purpose the parathyroid glands seem peculiarly ill-adapted. Unlike the thyroid gland where partial removal reduces correspondingly the hormonal output, the parathyroid glands can be reduced in number with no noticeable effect on the general metabolism, showing that their product is not well regulated quantitatively; and far from containing a variety of cell types able to secrete hormones known to have different actions, as is the case with the hypophysis and some other endocrine organs, the parathyroid glands have but one type of cell in different phases of activity⁷, and only one product, parathormone, is recognized. While there is abundant proof that hyperparathyroidism results in the bone changes characteristic of osteitis fibrosa, the normal parathyroid glands are not equipped as "regulators" for the balance called for in the modeling of growing bones.

Another agent which is now recognized as able to induce osteitis fibrosa is the female hormone, thieelin. Bremer in 1941 noted that the description of its action given by Silberberg and Silberberg in 1938 almost parallels that of Burrows in the same year concerning the effect of parathormone. In the search for an agent better suited than is parathormone

to control the undercutting, and thus regulate the future shape of the bone, the author treated a series of young rats with theelin. The extent of the increase in bone resorption which may be attained in a rat by the injection of this hormone for a few weeks can be measured by comparison with the normal bone (Figs. 1-1 and 1-2). In contrast to the normal bone, the erosion in the theelin-treated bone is much greater. The trabeculae



FIG. 1

Fig. 1-1: Photomicrograph ($\times 40$) of a sagittal section of the tibia, including the proximal epiphyseal line, of a normal rat forty-seven days old, shows widespread moderate destruction of bone trabeculae.

Fig. 1-2: Photomicrograph ($\times 40$) of a sagittal section of the tibia of a rat fifty days old, after 4500 international units of theelin had been given in twenty-one days. Note the increase of bone destruction and fibrosis.

Fig. 1-3: Photomicrograph ($\times 40$) of a sagittal section of the tibia of a rat fifty-four days old, after forty-five milligrams of oreton had been given in thirty days. Note diminution of destruction and smooth contour of bone.

Fig. 1-4: Photograph of a frontal section of the proximal end of a human tibia. (Reproduced from Triepel¹³.)

Fig. 1-5: Photograph of a frontal section of the distal end of a human tibia. (Reproduced from Triepel¹³.)

are more massive, as often occurs, for the whole process of bone-building and bone-shaping has been intensified by the treatment, but the most significant change is the more rapid erosion of some of the trabecular tips and the deep, widespread invasion by mesenchymal tissue of the enlarged marrow cavities. This resembles osteitis fibrosa, but in a minor degree. For the problem at hand, the important point is that theelin can increase the normal erosion at the surface of the bone, which thus shows a deeper, more irregular etching.

For theelin and other estrogens an antagonistic principle is ready at hand. All bodies, of either sex, contain a supply of both estrogens and androgens. Their antagonistic action is well known in many organs, and in 1938 was proved specifically for bone by Gardner and Pfeiffer who showed that the effects to be expected following the injection of theelin could be suppressed by the subsequent injection of testosterone. In the present series, with the idea that theelin was always normally present, testosterone was given to normal rats. Comparison of these bones (Fig. 1-3) with the normal shows a definite reduction in the erosion, as indicated by the shallower indentation and the smoother contour of the bone. This gives another proof that the normal erosion is caused by the presence of theelin, though in both cases it is quite possible that the sex hormone acts through the medium of the parathyroid glands. If excess of theelin results in an increase of the etching process, and excess of testosterone in its inhibition, it seems reasonable to assign to these two hormones, and not to that of the parathyroid glands, the rôle of regulator for the shaping of the bones, and to assume that a proper balance between them is the condition requisite for the production of normal forms.

As for the choice of the specific locations of the areas of bone resorption on the surface of any bone, the author has only suggestions to offer. It is known that resorption attacks by preference the youngest, most recently formed matrix; this would account for its occurrence in the sub-epiphyseal region, but not for its limitation to the periphery of this region and to only certain portions of this periphery. Stockard in 1921 asked the question: "If the internal secretions in the blood produce these peculiar growths, why do they not always act on all similarly growing parts in a similar manner?" The answer may lie in the position and the permeability of the regional veins. It has been shown that for dyes of certain grades of diffusibility, the cutaneous venules are the most permeable part of the vascular tree¹⁰,—perhaps because of their thin walls and the slowness of the current. In the neighborhood of the epiphyseal line, the vascular tree shows veins with walls composed only of endothelium, which grow larger as they approach the surface of the bone and assume additional coats only in their passage through the periosteum. Their exit is marked in the adult by an incomplete circle of perforations just below the epiphyseal line⁴. In the present series of bones of young growing animals, they seem to predominate in the areas of deepest etching. Röhlich finds similar thin-walled veins at the margin of the marrow cavity of the shaft, a

region marked even in the adult by evidences of slow resorption. If the escape of the hormone from the vessels simulates the diffusion of dyes (of which there is no present knowledge), the special resorptive activity in these regions becomes understandable. This offers a theory worthy of due consideration.

The mention of androgens and estrogens suggests inevitably the differences between the two sexes. There is a general feeling that female bones are more delicately molded than male. Anthropologists, however, hesitate to give too much weight to such differences. Given the whole skeleton, or the pelvis, or to a lesser degree the skull, identification can be made with some assurance; but, if only single long bones are available, the problem is much more difficult. It is true that female bones cease their growth at an earlier age than male¹², but size is no criterion in the adult. The greater musculature in the male causes more rugged surface markings, but the variables are so great that little weight can be given to these characteristics. One characteristic is considered fairly dependable,—the depth of the bone fossae is greater in the female in 60 to 65 per cent. of all cases. This agrees with the major premise of the present paper, for the presumable preponderance of estrogens in the female would be reflected in the greater erosion of subepiphyseal bone.

One other, only slightly related, consideration of some interest to clinicians is brought out in this study. The internal architecture of adult bone is usually considered the result of the rearrangement of the cancellated portion, so that the trabeculae come to lie in the proper orientation to withstand stress or strain. This is undoubtedly true as a general rule, but the two photographs (Figs. 1-4 and 1-5) reproduced here from Triepel's monograph show that rearrangement does not always occur. The closed epiphyseal plate can be recognized crossing the bone horizontally, and, at the upper end of the tibia, turning slightly downward as it nears the periphery. The diaphyseal trabeculae dependent from it at practically right angles here slant inward, being oriented by the vertical rows of cartilage cells which were present before the closure of the plate, as is shown by comparison with the young rat bones. The trabeculae meet the thin cortical plate, which is absent in younger stages and only develops when growth ceases, at acute angles sufficiently narrow to be considered an adaptation for the purpose of distributing the weight. At the lower end of the tibia, on the other hand (Fig. 1-5), the edges of the epiphyseal plate turn toward the joint, away from the diaphysis, and the trabeculae meet the cortex at a much less advantageous angle. Their orientation has been determined by the rows of cartilage cells; there has been no adaptation for service. It seems that these peripheral trabeculae, which during the modeling of the bone have suffered continual erosion and borne no weight, are incorporated into the system without change and only by chance sometimes fit the general architectural scheme. Where this does not take place, the bone is especially liable to fracture.

SUMMARY

The shape of long bones is governed to a certain degree by the extent of the surface erosion in the subepiphyseal region. The erosion shows the characteristics of osteitis fibrosa, and may be considered as similar to the initial stage of this disease. The disease may be caused by hyperparathyroidism, but the parathyroid glands are shown to be ill-adapted for the rôle of "regulators" of normal bone growth. The erosion can also be increased by theelin, and inhibited by testosterone. The balance between these two antagonistic principles probably regulates the intensity of the bone etching and maintains normal control of bone shapes. The greater depth of the fossae often recognizable in female bones may be due to an excess of estrogens. It is suggested that the location of the areas of erosion is determined by the position of the thin-walled veins of the subepiphyseal region.

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FEMORO-ISCHIAL TRANSPLANTATION *

BY DAVID M. BOSWORTH, M.D., NEW YORK, N. Y.

It has been generally recognized that in tuberculosis of the hip joint, where the head and neck of the femur have been extensively destroyed, the standard methods for securing ankylosis are either impossible to carry out, or the results are too poor to warrant their use. At Sea View Hospital a number of such problems have always been present in the past. These patients were noted in a review of those for whom rehabilitation had not been possible. Recognizing the close approximation between the adducted femoral shaft and the tuberosity of the ischium, it was believed that severance of the femoral shaft and transplantation of its sharpened end to the ischium would result in a high percentage of synostoses. It was reasoned that the ischium has great osteogenetic properties (as seen after fracture), and that the end of the femur, with the marrow cavity exposed after being severed at a level below the sclerosis caused by tuberculosis, might likewise have great osteogenetic properties. The matter was considered for some time, and finally in December 1936 a femoro-



FIG. 1-A

FIG 1-B

M. P. Proved tuberculosis of the hip of fifty years' duration. Patient had been operated upon twenty-three times.

Fig. 1-A: December 1, 1936. Preoperative roentgenogram.

Fig. 1-B: January 25, 1939. Solid weight-bearing union was secured by femoro-ischial transplantation in one stage.

* Read before the Annual Meeting of the American Orthopaedic Association, at Toronto, Ontario, June 12, 1941.

ischial transplantation was performed on the first patient. Since that time eight more operations for femoro-ischial transplantation have been performed.

STATISTICAL DATA

In spite of the difficulty of securing tuberculous tissue in old burned-out lesions, the organism was definitely proved by section or smear in seven of the nine patients operated upon. One of the two patients whose hip was not proved to be tuberculous had a proved tuberculous knee joint, and the other had chronic lung tuberculosis. The age range was from twelve to fifty-two years, with an average of thirty years. Two patients were colored and seven were white. There were six "Americans", one Irishman, one Slav, and one Italian. In six patients the right hip was involved and in three, the left. Neither compensation nor lawsuit was a factor in any case. The average duration of the disease was twenty years. The onset in all but two instances was in early childhood. Complete disability for bearing weight without crutches, brace, or other support had been present in each instance for most of the duration of the disease. Many operations had been carried out on these patients. In four instances sinuses had been continuously present throughout the



FIG. 1-C

FIG. 1-D

M. P. Gross specimen of synostosed femoro-ischial transplantation, secured at autopsy over two years after weight-bearing. Death was due to a renal lesion and peritonitis. There was solid ankylosis in good position.

disease was quiescent. The concentrated specimens of two patients had low positive sputum ratings on the Gaffke scale.

Preoperative Care: Hip fusions previously attempted in seven of the patients had resulted in failure. All had been under extensive treatment of some kind, and one patient had had twenty-three operative procedures carried out on the hip (Fig. 1-A).

Complications: Shock of moderate degree was encountered once, and of slight degree, once. Deaths have occurred in three instances up to the present time. One postoperative death occurred at twenty-four hours, and, by autopsy, proved to be from an embolus. A second patient died three months postoperatively from uraemia with massive amyloidosis. The third patient, who died twenty-eight months postoperatively, had been fully ambulatory and bearing weight for two years preceding death (Fig. 1-B). She had extensive kidney involvement and died from uraemia and peritonitis.

Results: Of the nine patients operated upon, two died before ankylosis could be expected to occur. Of the seven others, five secured complete ankylosis, and one operated upon three months ago appears by roentgenograms to have satisfactory union. In one case the operation is definitely a failure. In this patient multiple sinuses preceded operation, and a single sinus still persists; ankylosis has not occurred. Where ankylosis has been secured, it has been with between 20 and 45 degrees of flexion, and with from little to moderate abduction. All clinical findings such as gait and sitting posture compare with results from ankylosis of the hip by routine procedures. The patients sit fairly well with 20 degrees of flexion, and very well when flexion is increased to from 30 to 40 degrees. Gait seems to be influenced by the amount of shortening present rather than by any other factor. Four of the five in whom ankylosis has been secured have been fully rehabilitated as far as weight-bearing is concerned. Full weight-bearing was secured in from four months to one year (Figs. 2-B, 3-B, and 4-C).

OPERATION

First Stage: When sinuses exist, it may be necessary to do a so-called first stage in an effort to get rid of the diseased trochanteric portion of the femur, remnants of the neck, fibrous tissue, and granulation tissue. The first operation then consists in an oblique division of the femur above the level of the tuberosity of the ischium, the pointed portion of the distal fragment jutting up and inward, the trochanteric mass, fibrous mass, and granulation tissue all being removed down to the fibrous tissue covering the old involved acetabulum and lateral surface of the ilium. In view of the usefulness of present drugs, such as sulfathiazole, it may be that some of these dissections can then be closed with the implantation of such chemical agents. The author has not done this to date, but has left the wounds open, packing them with vaseline gauze and treating them by the method of Orr, carbolicizing them at interval dressings as necessary.

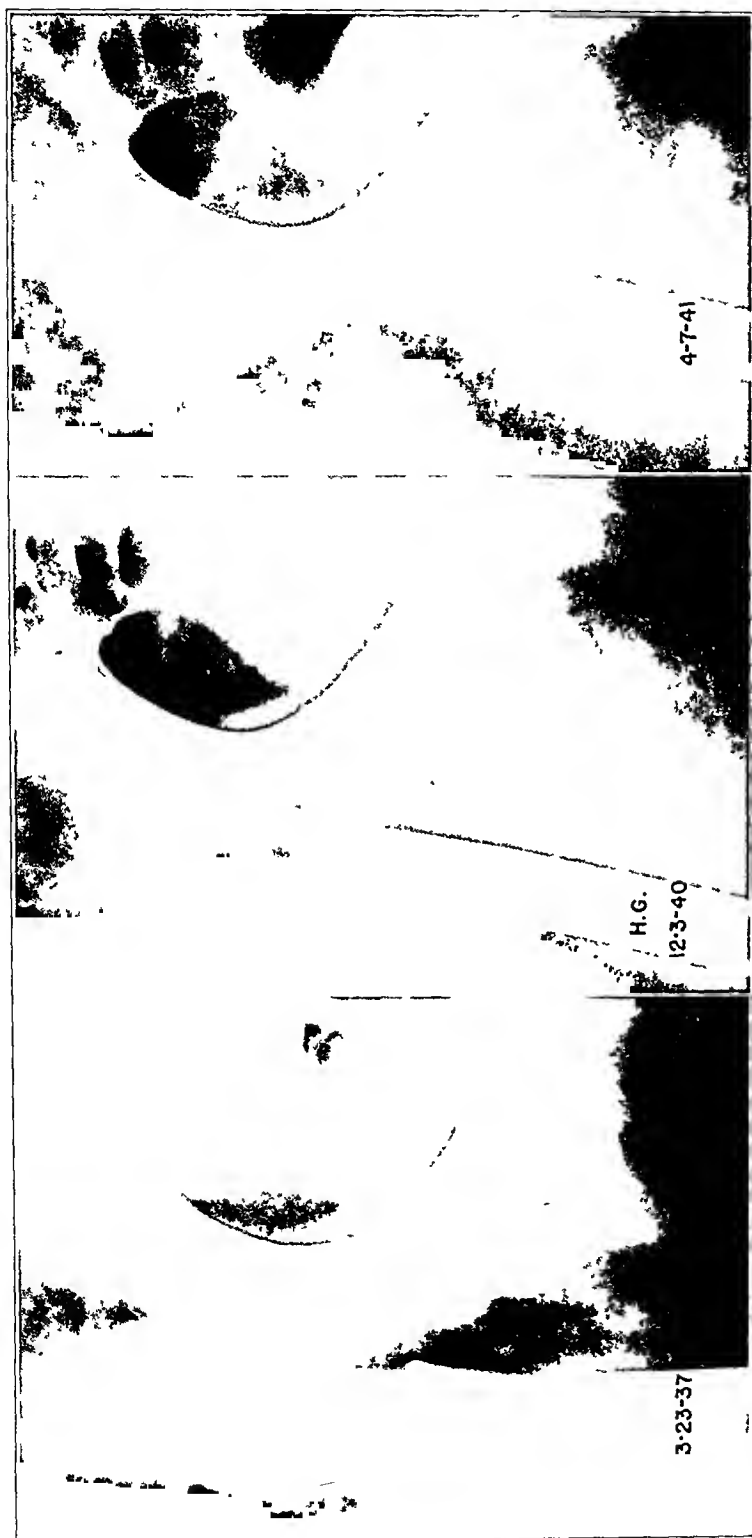


Fig. 4-A

Fig. 4-B

Fig. 4-C

H. G.: Proved tuberculous of the hip of twenty years' duration in a patient twenty-three years old. Fig. 4-A: March 23, 1937. Resection of the head and neck had been done previously elsewhere. Note fibrous tissue and underlying sequester. Fig. 4-B: December 3, 1940. Roentgenogram shows healed condition following first-stage amputation of the trochanter. Fig. 4-C: April 7, 1941. Roentgenogram shows early union five months postoperatively, the joint is clinically solid.

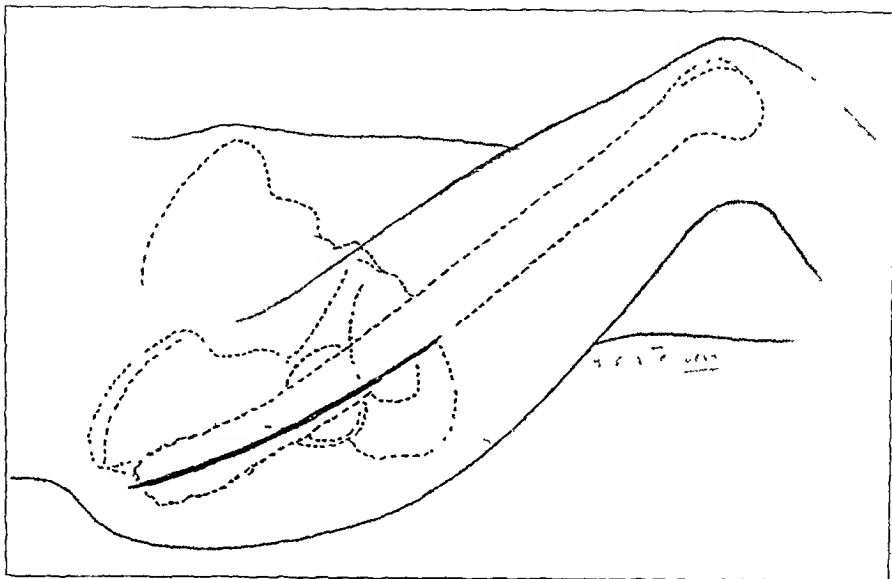


FIG. 5-A

Drawing shows lateral incision.

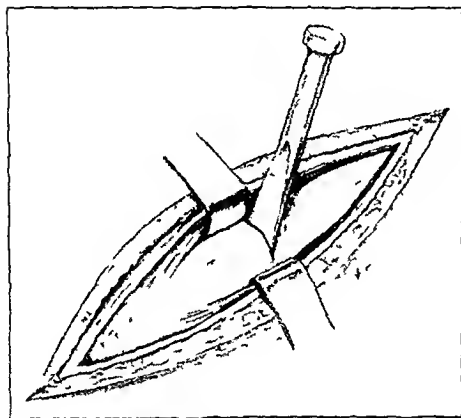


FIG. 5-B

Fig. 5-B: Subperiosteal dissection and osteotomy of femur upward and inward.

Fig. 5-C: The distal fragment is retracted.

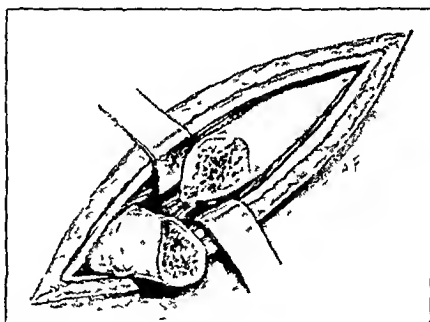


FIG. 5-C

Second Stage: The femoro-ischial transplantation itself can be done in one stage in all wounds without sinuses, and in the other patients when healing has been secured following the first stage. It should be known in advance that this is a difficult procedure for both the surgeon and the patient. Where sinuses exist away from the operative field, it is sometimes possible to do the femoro-ischial transplantation at a level below any roentgenographic evidence of the disease process. The procedure is carried out through a lateral incision, which extends from the trochanter well down on the femur through the fascia and vastus lateralis, with subperiosteal dissection of the femoral shaft opposite and just above the level of the tuberosity of the ischium. The shaft is then divided by osteotome upward and inward in an oblique fashion, so that

there is a point left on the distal fragment directed upward and inward. By blunt dissection the tuberosity of the ischium can be exposed on its distal and lateral surfaces, following retraction of the distal fragment of the femur. Though the dissection of the ischium can be seen by retraction and extension of exposure, the author has generally made the ischial exposure blindly and through a smaller opening than would otherwise be necessary. After denudation of a suitable place in the tuberosity of the ischium, a hole can be gouged out of the tuberos-

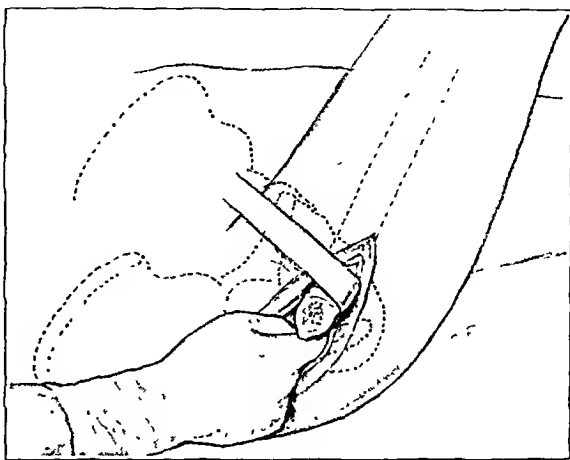


FIG. 5-D

Fig. 5-D

The ischium is located by palpation.

FIG. 5 E

A bone defect is created in the lateral surface of the ischial tuberosity.

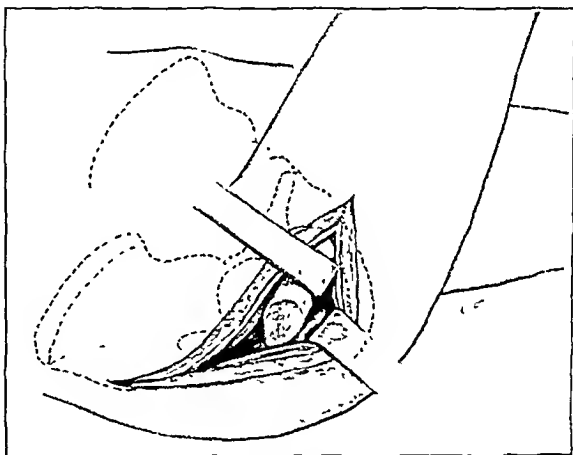


FIG. 5-E

Fig. 5-F

The sharp end of the femoral shaft is buried in the ischial defect. The proximal fragment of the femur, which has been removed for illustrative purposes, may be actually left *in situ*.

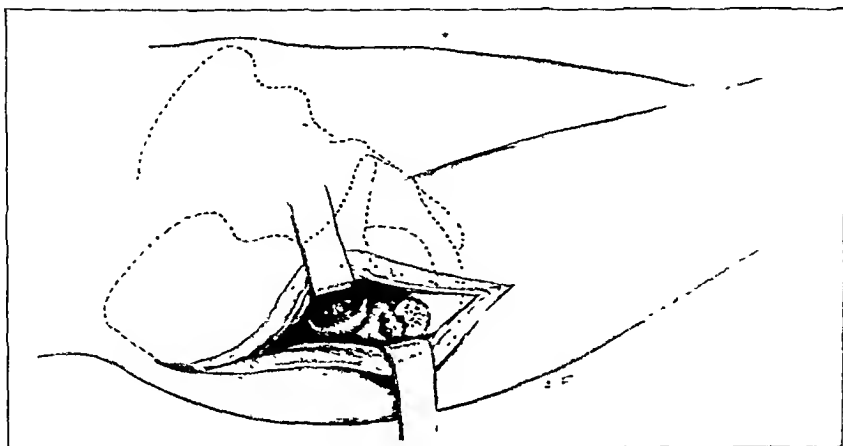


FIG. 5-F

ity with a large curette. It should be noted that some judgment must be exercised as to the level of the femoral osteotomy. All of these legs show gross shortening and some length can usually be gained. The tightness of the fit of the femoral end in the tuberosity of the ischium, caused by the tension produced following implantation when the bone is cut long, tends toward stability and coaptation of the fragments. After the site has been prepared in the ischium, a large bone skid is placed with its point in the ischial defect, and the freshened end of the distal femoral fragment is levered into the defect in the ischium with the thigh flexed to about 90 degrees. By straightening the thigh to about 150 degrees, marked tension is then put on the musculature and fascia, jamming the end of the femur well into the prepared defect in the ischium (Figs. 5-A, 5-B, 5-C, 5-D, 5-E, and 5-F). It will be found that the periosteum and fibrous tissue, originally covering the denuded site in the ischium, surround the end of the femoral shaft in a semicuff. Little abduction should be used, shortening being compensated for later by prosthesis. The wound is well washed with ether to remove fat and debris, and is closed in layers with silk. A plaster double-hip spica is used for several weeks; the good leg is later removed from encasement, but the cast is not changed for at least three months. Roentgenographic evidence of union should be the guide for release from plaster retention and for the beginning of weight-bearing.

SUMMARY

The operative procedure described could be used in securing ankylosis in instances of old suppurative arthritis of the hip, aseptic necrosis, and ununited traumatic lesions, where ankylosis is desirable but difficult to secure, as well as for cases of tuberculous hip disease.

Femoro-ischial transplantation gives the same cosmetic, weight-bearing, and functional result (seated posture) as ankylosis of the hip joint.

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CALCIFICATION AND OSSIFICATION

III. THE RÔLE OF LOCAL TRANSFER OF BONE SALT IN THE CALCIFICATION OF THE FRACTURE CALLUS *

BY MARSHALL R. URIST, M.S., M.D.,† BALTIMORE, MARYLAND

From the Johns Hopkins Medical School, Baltimore, Maryland

The problem of the local transfer of bone salt in the healing of fractures can be stated in the following questions: (1) Is there a transfer of bone salt from bone to fracture callus, and, if so, how important a part does it play as a stimulus to healing, and as a source of the minerals required in the calcification of the callus? (2) If such a transfer to the callus occurs, is the bone salt derived from the portion of the shaft which becomes necrotic as the result of injury, from the uninjured and living cortical bone, or from both? (3) If such a transfer occurs, what is the mechanism of removal of the bone salt from preformed bone, of its local transport, and of its deposition in the calcifiable tissues of the fracture callus? (4) If local transfer of bone salt plays a significant part in the healing of fractures, can this process be supplemented by the local introduction of the minerals needed in the calcification of the fracture callus?

By applying the methods previously described^{38, 39} for the study of the calcification process in experimental fractures, an attempt has been made to find answers to these questions. Because, as previously shown³⁹, the rachitic animal provides material better suited for the analysis of the process of calcification in the fracture callus than does the normal animal, the experiments reported have been carried out on rachitic rats. The uncalcified callus in rickets provides an ideal substratum for observations upon the local distribution and utilization of exogenous mineral and calcium salts transferred locally.

In the course of previous experiments³⁹, the local transfer of calcium salts from bone to callus was suggested by the observation that mineral deposits develop in the rachitic callus in the later stages of healing. This was termed *spontaneous calcification* to differentiate it from calcification induced by experimental means, and is recognizable as deposition of bone salt in the fracture callus in the absence of corresponding new calcification in the sites of new-bone formation elsewhere in the skeleton. Because the callus calcifies while the rachitic metaphyses remain unmodified, *spontaneous calcification in healing fractures* bears no necessary relationship to *spontaneous healing of rickets*, in which new calcification and early healing of the rachitic lesions all over the body occur in untreated individuals. Spontaneous calcification is much slower in rate than is calcifica-

* This work was aided by a grant from the Josiah Macy, Jr., Foundation.

† Henry Strong Denison Scholar for 1940-1941.

tion in rachitic animals subjected to treatment. In spontaneous calcification, even at the height of its progress, there are wide osteoid borders around incompletely calcified trabeculae, revealing the existence of a long interval of time between ossification and calcification. However, that calcium deposition is continuous, after spontaneous calcification is initiated, is shown by the fact that there is a continuous increase in the proportion of calcified to uncalcified callus as healing continues.

EXPERIMENTAL PROCEDURE

The results presented herein consist of observations upon histological sections of bones showing: (a) spontaneous calcification in rachitic fractures without interference, and (b) calcification in rachitic fractures as modified by (1) the administration of inorganic phosphate, (2) local implantation of ground bone, (3) introduction of devitalized onlay bone grafts, and (4) local injections of colloidal calcium phosphate. The rachitic rats, experimental fractures, serum calcium and phosphorus determinations, and microscopic preparations of the bones were obtained according to the methods described in previous papers^{38, 39}.

Spontaneous Calcification in the Fracture Callus in Rickets

Fractures were prepared in five litters of rachitic rats and allowed to heal, without interference, for periods of eight to twenty-eight days, when



FIG. 1

Photomicrograph ($\times 88$) of longitudinal section through fracture of undecalcified tibia of rachitic rat, aged fifty-nine days, after ten days of healing, showing the earliest stages of spontaneous calcification in the callus osteoid. *Sh*, indicates shaft; *Po*, periosteum; *Os*, callus osteoid; *Am*, amorphous deposits of silver; *Cry*, crystalline deposits of silver. (All sections illustrated were impregnated with silver nitrate and counterstained with hematoxylin-eosin.)

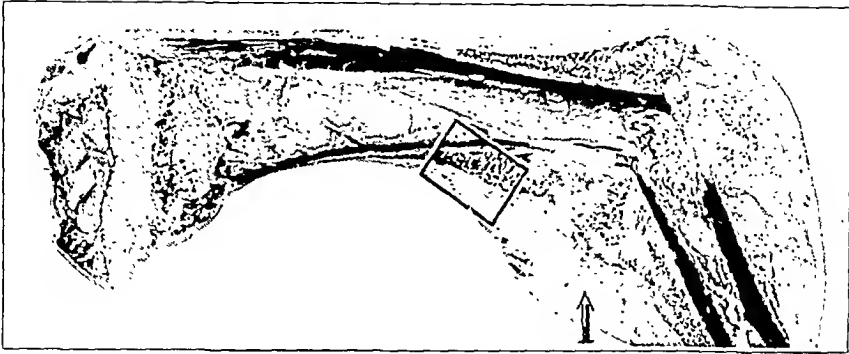


FIG. 2

Photomicrograph ($\times 6$) of a longitudinal section through the undecalcified right tibia twenty-five days after fracture. Rachitic rat, seventy-four days old, weaned to Steenbock-Black rachitogenic diet 2965 at twenty-one days of age. There is complete absence of calcification in the epiphyseal cartilage and upper metaphysis, with new calcification widely distributed in the portion of the subperiosteal callus adjacent to the shaft, and in endosteal callus. Compare with figures in previous papers: Fig. 7²⁸, Figs. 20, 21, 22, 23, and 26²⁹. Rectangle indicates area shown in Fig. 3, a serial section. Arrow indicates area shown in Fig. 4, a serial section.

the bones were excised for microscopic study. Under these conditions spontaneous calcification was observed in the callus as early as the tenth day of healing, but was found more frequently between the tenth and the fifteenth days. About one-third of the animals showed little or only be-



FIG. 3

Photomicrograph ($\times 53$) of area shown by rectangle in Fig. 2, but from adjacent section, showing the density of the deposits of bone salt found in an advanced stage of spontaneous calcification. *Sh*, indicates shaft; *Po*, periosteum; *Os*, subperiosteal callus osteoid, with faint amorphous deposit of silver; *Sp*, spontaneous calcification in the callus osteoid; *Mw*, marrow.

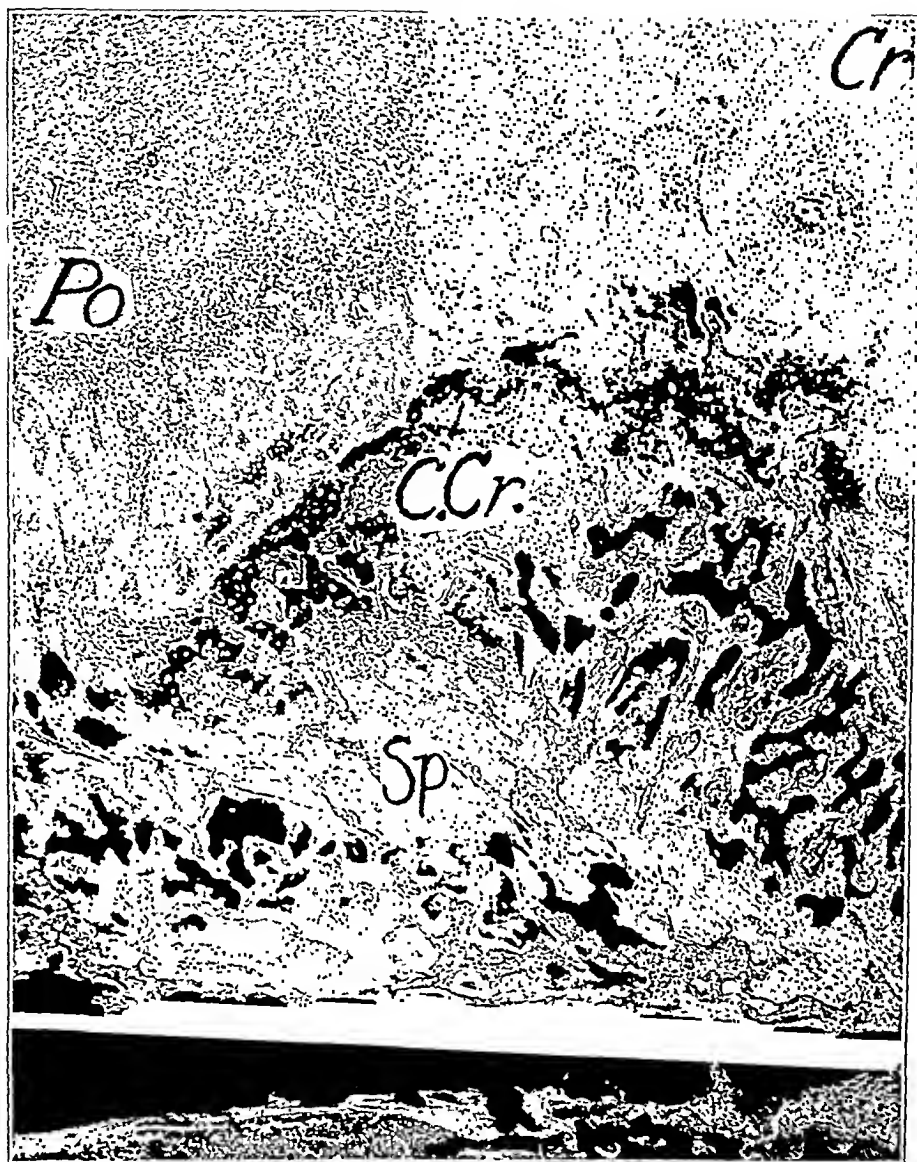


FIG. 4

Photomicrograph ($\times 35$) of an area around the rarefied fracture ends, indicated by the arrow in Fig. 2, but from an adjacent section, showing the final stages of the replacement of cartilage by osteoid. The cartilage, as well as the osteoid beneath the periosteum, is uncalcified, but solid union is initiated by the spontaneous calcification of the cartilage and bone matrix nearer the shaft. *Po*, periosteum; *Cr*, uncalcified cartilage; *C. Cr*, calcified cartilage; *Sp*, calcified osteoid.

ginning calcification as late as the fifteenth to the twentieth day, and, in occasional litters, notably those with very florid rickets or with bones showing wide metaphyses containing no old calcium deposits around the primary marrow cavity, the onset was sometimes as late as the twenty-fifth day of healing. Both the type and severity of the rickets, and the occurrence of spontaneous calcification were quite uniform among littermates reared under identical conditions.

Progress and Distribution of Calcium Deposition

Spontaneous calcification begins in the trabeculae of subperiosteal and subendosteal osteoid tissue overlying the fragments of the shaft for some distance from the fracture line. The bone salt is first seen in undecalcified sections impregnated with silver nitrate, as amorphous deposits or as fine crystals (Fig. 1). These deposits, which first appear in the callus osteoid applied to the surface of the cortical bone, spread outward toward the periosteum and later upward and downward toward the fracture line. The calcification gradually increases in density and in extent, but the dense calcification does not extend far enough to reach the periosteum. It usually terminates sharply, with the margin, parallel to the periosteum, facing a wide zone of osteoid (Figs. 2 and 3). This osteoid, lying between the periosteum and the osteoid which has calcified spontaneously, often contains small amounts of bone salt in amorphous deposits (Fig. 3), but up to the time that union occurs dense calcification is limited to the deeper portions of the callus.

Spontaneous calcification of the callus cartilage matrix, in all instances, begins after calcium deposits are widely distributed in the sub-



FIG. 5

Photomicrograph ($\times 60$) of a section through the subperiosteal callus in a rachitic rat, aged sixty-seven days, eighteen days after a surgical fracture which had been implanted with particles of bone shown in Fig. 6. Beginning calcification in the hypertrophic cartilage facing the rarefied shaft, the surrounding callus osteoid remaining uncalcified, simulating the initial calcification of the epiphyseal cartilage in the earliest stages of healing of rickets (See Fig. 21 of a previous paper¹²). The implanted bone did not contribute to the local source of bone salt. *Sh*, shaft; *Po*, periosteum; *Cr*, cartilage; *CCr*, calcified cartilage.

periosteal osteoid. In a litter of fractured animals in which calcification began in the subperiosteal osteoid before fifteen days of healing, the matrix of the hypertrophic cartilage facing the shaft showed new calcium deposits at the eighteenth day. At this time, in addition to the hypertrophic cartilage, there is an abundance of fibrocartilage, chondro-osteoid, and fibrous connective tissue between the fracture ends and separating the cartilage from the subperiosteal bone. The initial calcification in the central callus is limited to the cartilage, and does not include the tissues in which it is embedded (Figs. 4 and 5). This selectivity is identical with that seen during the early stages of calcification induced by vitamin-D or phosphate administration, and confirms the previous observation³⁹ that the matrix of chondro-osteoid is not immediately calcifiable.

In spontaneous calcification of the cartilaginous callus, as in experimentally induced calcification, the deposits are laid down in its matrix only after the fibrocartilaginous tissue is invaded by blood vessels, mesenchyme, and osteogenic cells. The occurrence of calcification in the hypertrophic cartilage, in advance of the surrounding osteoid and chondro-osteoid, resembles the stage between the calcification of the epiphyseal cartilage and the healing of the rachitic metaphysis following phosphate or vitamin-D administration³⁹. As the fibrocartilaginous callus is invaded, remnants of calcified cartilage, suggestive of the primary spongiosa of normal cartilage-bone junction, become enclosed in ingrowing osteogenic tissue and lamellae of new bone. When contact between the subperiosteal intramembranous bone and these central formations of new endochondral bone is established, the growth of bone then continues across the fracture line, and union is at irregular points.

Changes in the Shaft Accompanying Spontaneous Calcification of the Callus

At the time of the early stages of fracture healing in the experimental rachitic fractures which have been previously described³⁹, the compact bone of the shaft is relatively heavily impregnated with bone salt. There are only thin layers of new osteoid between the well calcified bone lamellae and the osteogenic cells which line the haversian canals, and the greater part of the cortical structure stains with silver to the maximum density. Shortly after the injury, necrotic cortical bone appears at the fracture ends, but this usually covers only a millimeter or less of the shaft, and is resorbed in the early stages of callus formation. As healing progresses, and as the callus organizes about the shaft for some distance from the fracture line—often one-third the total length of the shaft—the architecture of the enclosed compact bone is transformed and reconstructed. In the course of this process the bone salt is mobilized and is, presumably, in transit in the tissue fluids in solution, colloidal or ionic, but not aggregated in a form which can be visualized by silver-staining.

In a previous paper³⁸, the rarefaction of the shaft enclosed in callus was described in normal bones. In rachitic fractures, just as in normal fractures, it is observed that the vascular channels of the cortical bone be-

come widened and filled with osteoclasts, osteogenic tissue, and fibrous connective tissue, and that the shaft is reduced to such a state of porosis that the compacta becomes more nearly like spongiosa (Figs. 3, 4, and 5). As the callus reaches its maximum size, the cortical bone within it appears perforated by tortuous channels through which blood vessels, carrying an adnexa of mesenchyme and osteogenic tissue, pass from the marrow cavity and endosteal callus into the subperiosteal callus. At this stage, generally twenty-five to twenty-eight days of healing, when rarefaction of the shaft is at a maximum, the size of the callus and the distribution of spontaneous calcification are also at a maximum. With gradual resorption of callus there is reconstruction of the compacta. The new bone lamellae laid down concentrically in haversian systems are at first, as is the adjacent callus osteoid, only partially calcified, but gradually increase in density as the size of the callus becomes reduced. As the callus becomes so organized that union is approached, calcification is extended to the tissues between the fracture ends.

Union

Spontaneous calcification of the osteoid and hypertrophic cartilage matrix between and around the fracture line may be regarded as the initial stage of union, although for some time the density of these deposits is so slight that, in ordinary roentgenograms (See illustrations of the papers of Compere, Hamilton, and Dewar; and Ham. Tisdall, and Drake), there is little or no suggestion of the presence of calcification in the rachitic callus. Owing to the presence of uncalcified chondro-osteoid, fibrocartilage, and dense fibrous connective tissue across the fracture line, the continuity of the newly calcified tissue is irregular and interrupted at

TABLE I
RELATION OF SPONTANEOUS CALCIFICATION IN THE CALLUS TO THE
CONCENTRATION OF CALCIUM AND PHOSPHATE IN THE PLASMA

Group	No. of Animal	Days of Healing	Calcium (Millimoles Per Liter)	Phosphorus (Millimoles Per Liter)	No. of Animal- Showing Spontaneous Calcification
Fractures.....	5	10	2.74	1.58	0
Controls.....	4	—	2.76	1.56	—
Fractures.....	4	12	2.79	1.84	1
Controls.....	4	—	2.78	1.80	—
Fractures.....	4	18	2.77	1.58	3
Controls.....	3	—	2.80	1.55	—
Fractures.....	3	22	—	1.45	3
Controls.....	3	—	—	1.44	—

various points. In some cases, there is actual retraction of the fibrocartilaginous callus between the fracture ends, suggesting the development of changes leading to non-union.

Serum Calcium and Phosphorus During Spontaneous Calcification of the Callus

Four litters of rachitic rats were divided into two groups, one of which served as a control. Fractures were prepared in rats in the other group, and the bones were allowed to heal for periods of ten, twelve, eighteen, and twenty-two days. At these times, the animals were sacrificed and the blood in each group pooled for serum calcium and inorganic phosphorus determinations. The bones were sectioned manually and subjected to the silver-nitrate "line test" to ascertain the presence or absence of calcification in the callus. The results are summarized in Table I.

There were no significant differences in the levels of the serum calcium and phosphorus in the pooled sera of fractured, as compared with unfractured, littermates; although in sections of the bones there were mineral deposits in the callus in many instances. Therefore, it seems clear that at the time of spontaneous calcification of the callus the state of the blood of fractured and unfractured littermates is the same with respect to calcium and phosphorus.

Spontaneous Calcification as Modified by Generalized Calcification

Three to four littermates of each of the five litters of rachitic rats, in which spontaneous calcification has been described, were given daily intraperitoneal injections of phosphate solution in uniform doses. The phosphate solution used was a mixture of 80 per cent. of one-tenth molar secondary sodium phosphate ($M/10 Na_2HPO_4$) and 20 per cent. of primary sodium phosphate ($M/10 NaH_2PO_4$), of which the hydrogen-ion concentration at 38 degrees centigrade corresponded approximately to pH 7.35. The standard dosage employed was 2.5 cubic centimeters (containing approximately 7.5 milligrams of phosphorus) per 100 grams of rat weight. The daily injections were begun in four litters at eight days following the fracture, and in one litter at fifteen days.

These experiments are presented in order to demonstrate the contrast between calcification arising from humoral sources and that from local sources. The control, progress, and maintenance of calcium deposition in the rachitic callus by means of inorganic phosphate administration were described in detail in a previous paper³⁹, but at this point it is to be shown that calcification of the callus in conjunction with generalized healing of rickets follows a pattern which is peculiarly different from that of spontaneous calcification.

In rachitic rats with healing fractures, injected intraperitoneally with phosphate on the eighth day of healing, calcium deposits may be found on the tenth day in the callus osteoid which lies immediately under

the periosteum, and there are also the expected calcification and early healing changes in the rachitic epiphyseal cartilage and metaphysis. With continued daily injections from the tenth to the twelfth day of healing, the initial subperiosteal deposits increase in density, and new deposits form farther inward toward the shaft. Continuing from the twelfth to the fifteenth day, partial calcification of the osteoid appears everywhere in the subperiosteal callus and in the various parts of the fibrocartilaginous callus in contact with osteogenic tissues. With continued injections from the fifteenth to the twenty-fourth day, there is usually rapid invasion and replacement of the fibrocartilaginous callus by bone, and, in a few cases, there may be enough calcified bone across the fragments to regard the fracture as microscopically united.

In this way the callus calcifies by progressive impregnation which spreads centripetally from the periosteum to the shaft; and, if in the interim spontaneous calcification has occurred, its presence and contributions to the deposits are obscured by the rapidity and completeness of the calcification derived from humoral sources (See illustrations of the paper of Urist and McLean³⁹).



FIG. 6

Photomicrograph ($\times 250$) of section showing necrotic bone eighteen days after implantation between the cortical ends of a surgical fracture in a rachitic rat. The particles of dead bone are encapsulated in fibrous connective tissue and absorbed with granular crumbling and disintegration of the bone matrix. The arrow indicates a macrophage shown in Fig. 7.



FIG. 7

Photomicrograph with an apochromatic immersion objective ($\times 3000$) showing a macrophage indicated by the arrow in Fig. 6, with cytoplasmic granules of silver-staining material, presumably bone salt.

In animals first injected with phosphate on the fifteenth day, granular deposits of bone salts, judged to originate in spontaneous calcification, are found, at the eighteenth day, immediately adjacent to the shaft, along with the denser deposits that form in the subperiosteal osteoid. The callus osteoid between these lines of calcification is either entirely free of bone salt or only very slightly impregnated with isolated patches of discrete crystals. This presumably represents an area being encroached upon from both the centrifugal direction of spontaneous calcification and the centripetal direction of calcification supported by humoral sources of the bone salt. Thus the local mechanism of delivering the materials necessary for building the bone salt does not differ from the more rapidly progressive humoral mechanism in its selection of the tissues undergoing calcification. Calcification occurs only in the osteoid and in

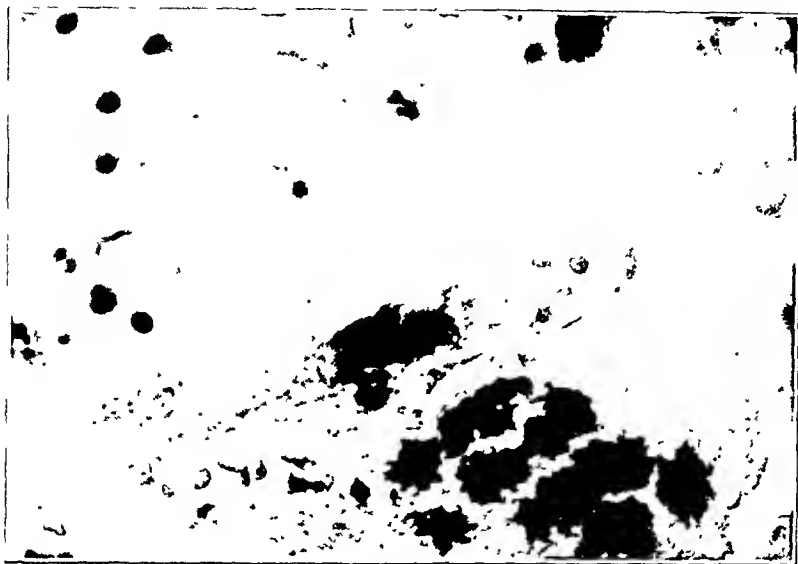


FIG. 8

Photomicrograph ($\times 670$) showing two fragments of dead bone undergoing decalcification and autolysis twenty days after implantation in the marrow cavity between the cortical ends of rachitic surgical fractures. The lower fragment has become so depleted of its mineral substance that the chemical reaction with silver nitrate results in the formation of large crystals of calcium salt. The effect is also seen in rapidly forming bone and in newly calcified osteoid, except that the crystals are smaller, and the direction of the process is the reverse,—calcification rather than decalcification (See Fig. 25 of a previous paper⁴⁹). The fragment in the upper part of the picture is seen in the final stages of autolysis. Inflammatory tissue and serous exudate comprise the surrounding background.

the hypertrophic cartilage in contact with invading mesenchyme or osteogenic tissue; likewise the resistant properties of the chondro-osteoid and non-osseous tissues are the same in spontaneous calcification as in generalized calcification resulting from vigorous antirachitic treatment.

The Callus of Rachitic Fractures Implanted with Devitalized Bone

Subperiosteal fractures were prepared surgically in two litters of rachitic rats. In one litter, approximately equal quantities by volume of ground bone were inserted between the fracture ends at operation. In the second litter, thin bone platelets of equal size were placed under the periosteum and applied to the shaft across the fracture line in the manner of an onlay bone graft. The particles of bone, cut from autoplasmic scapulae and ilia, had been devitalized in strong alkali and washed in distilled water. Similar surgical fractures were implanted with pieces of 60-degree paraffin of equal size in order to provide controls to show the effect of obstruction at the fracture line.

Ground Bone

The healing of rachitic fractures implanted with particles of dead bone follows the same course as that of undisturbed fractures, except that

the structure of the central fibrocartilaginous callus becomes modified by the cellular reaction to the presence of foreign bodies. The formation of uncalcified osteoid tissue, which begins some distance from the fracture line in the subperiosteum and subendosteum, proceeds rapidly in the first fifteen days of healing, as is characteristic of rickets, and there is little or no invasion of the central callus by bone. Instead of the central fibrocartilaginous callus being uniformly comprised of nodules of cartilage within and about proliferating fibrocartilage and fibrous connective tissue, there are distributed within it particles of the implanted dead bone surrounded by foreign-body giant cells and fibrous connective tissue. The closely outlying osteoid and cartilage of the rachitic callus show no calcium deposits or changes attributable to the presence of dead bone in the callus. The devitalized bone particles gradually decrease in size by the process of granular crumbling within the fibrous connective-tissue envelope, and stain deeply eosinophilic and to the maximum density with silver (Fig. 6). As this process progresses, the matrix stains poorly and irregularly with eosin, and the calcium content diminishes. An occasional particle appears which shows the silver salt aggregated in the background of uncalcified matrix (Fig. 8), and an occasional particle may be found which shows no bone salt in the disintegrating acellular tissue (Fig. 8).

In the fibrous connective tissue, and between the foreign-body giant cells surrounding the crumbling necrotic bone, are phagocytic cells, containing cytoplasmic granules of silver-staining material (Fig. 7). These cells resemble the macrophages which have been seen surrounding the necrotic cortical ends in normal healing fractures and but rarely in rachitic fractures³⁹.

Between fifteen and twenty days of healing, when calcification occurs in the subperiosteal regions and later in the cartilage of the implanted callus, the new deposits do not appear to be more dense than in the untreated controls or to differ in any way from those seen in the usual progress of unmodified spontaneous calcification.

Onlay Grafts

In one litter of rachitic rats, devitalized onlay bone grafts were introduced across the fracture in order to observe the fate of the implanted bone in the relatively unobstructed growing callus. The results appear the same as in the case of the callus implanted with bone particles. The grafts are absorbed rapidly and do not alter the usual progress of spontaneous calcification or the rate of development of the rachitic callus.

The Callus of Rachitic Fractures Injected with Colloidal Calcium Phosphate

In one litter of rachitic rats, the subperiosteal callus, beginning at seven days, was injected every two days with one-twentieth molar (M/20) of colloidal solution of calcium phosphate by means of a fine-caliber hypodermic needle. This solution was prepared by mixing solutions of one-tenth molar of calcium chloride (M/10 CaCl_2) and one-tenth molar of

balanced secondary sodium phosphate and primary sodium phosphate (M/10 balanced Na_2HPO_4 and NaH_2PO_4) in an equal quantity of pig serum which was used as the protective colloid. The bones were resected at intervals of three, five, and ten days from the eighth to the twenty-fifth day of healing.

Local injections of calcium phosphate in colloidal solution fail to initiate calcification of the osteoid tissue of the rachitic callus. The material is evidently received as if it were a chemical irritant. The callus tissues appear disorganized by local dilatation of the sinusoids and capillaries, by infiltration of large masses of polymorphonuclear leukocytes, macrophages, and inflammatory exudate, and by the formation of foreign-body giant cells and granulation tissue. In frozen-dried, hand-cut sections, stained with concentrated silver-nitrate solution, there were groups of macrophages containing granular material in the cytoplasm which stained after the manner of the phosphate salts. But histological sections did not reveal more than a suggestion of the presence of these cells. The advent of spontaneous calcification in the inner portion of the subperiosteal callus osteoid and cartilage was observed at the usual time in such areas as were not infiltrated with inflammatory tissue. The deposits are not more dense than those seen in untreated littermate controls.

DISCUSSION

Spontaneous calcification in the callus in untreated rachitic rats is characterized by (a) its *late appearance*, long after readily calcifiable tissues have appeared in the callus; (b) a characteristic *pattern* of distribution, first in the callus osteoid, adjacent to the callus-enclosed shaft, spreading outward toward, but not reaching, the periosteum; (c) a marked *limitation in the capacity* of the mechanism, resulting in deficient or defective union; (d) a definite *diminution in rate* of calcification; (e) appearance of calcification in the callus *without corresponding calcification or healing in the rachitic metaphysis*; (f) its occurrence *without the increase in calcium or phosphate concentrations in the plasma* characteristic of humorally induced calcification. These characteristics are sufficient to establish the fact that local transfer of calcium salts from bone to fracture callus may occur. They serve also to emphasize some of the limitations of this source of mineral in the calcification of the callus.

Local Calcium Salt as a Stimulus to Osteogenesis

There are repeated suggestions in the literature that calcium salts play an important part in stimulating osteogenesis. The earlier literature is reviewed by Wells. Axhausen suggested that the resorption of necrotic bone may be the stimulus to new-bone formation in healing fractures. The view of Leriche and Policard, that a "local excess of calcium" stimulates the differentiation of connective tissue into bone, has been much quoted, it being frequently inferred that the calcium salts are deposited concurrently in the new bone. Eden considered calcification of em-

bryonic connective tissue as the forerunner of ossification. All of these suggestions imply that deposition of the bone salt, following injury to bone, precedes rather than follows formation of bone.

It has previously been shown³⁸, in fractures in normal rats, that there is no indication of deposition of bone salt in the procallus, and that such deposition occurs only after the formation of a calcifiable tissue,—namely, the matrix of bone or of cartilage. The observations here reported, of the late appearance of spontaneous calcification in the rachitic callus, long after calcifiable tissues are present, constitute adequate evidence that the formation of osseous tissue in the fracture callus is not dependent upon the presence of bone salt.

The Shaft as a Source of Bone Salt

The foregoing observations indicate that the source of the mineral transferred from bone to fracture callus is that part of the shaft enclosed in the callus. As described by Cornil and Coudray, this portion of the shaft consists of two distinct parts,—the *necrotic* bone at and near the site of the fracture, and the *living cortical tissue*. The alteration of the structure of the shaft near the healing fracture has been described in gross specimens by Todd and Iler, in injected bones to show the course of the blood vessels by Lexer, and in undecalcified microscopic sections by Urist and McLean^{38, 39}. In general, the cortex is resorbed and rarefied preliminary to replacement of the old shaft by new bone. The adjacent subperiosteal and intramedullary callus reinforces the shaft while the fracture gap is being bridged by new bone.

Murray^{24, 25, 26} who considers local transfer of bone salt to be the most important source of mineral for the repair of fractures, contends that the source of the calcium is the dead bone at the site of the fracture. His views, derived chiefly from the implantation of calcium salts or devitalized bone into experimental fractures, will be considered further.

Urist and McLean have previously described^{38, 39} the fate of necrotic bone in fractures in normal rats, and have shown that it disintegrates and becomes decalcified, and is removed by a process which differs from the resorption of living bone. This process is at its height from the fifth to the tenth day of healing, and by the fifteenth day decalcification and disintegration of the necrotic fragments may be complete. On the other hand, resorption and reorganization of the living, callus-enclosed shaft, which begins with the first formation of the subperiosteal intramembranous bone, and continues throughout the growth and regression of the callus, reaches its height at the twenty-fifth to the thirtieth day of healing, by which time the shaft has become almost as porous as spongy bone. The course of reconstruction of the shaft in rachitic bone, as described in the present paper, is identical with that in normal animals, and is closely correlated in time with the spontaneous calcification observed in the rachitic fracture callus.

Moreover, the observations here reported demonstrate a close ana-

tomical relationship between the portion of the shaft undergoing rarefaction and the osteoid tissue in process of calcification, and fail to disclose such a relationship between necrotic bone and the distribution of its mobilized salts. Calcium salts, other than those contained in living bone, whether in tissue necrotic as a result of injury or artificially introduced, as will be shown later, are treated by the organism as foreign bodies, without their diffusion into adjacent tissues. Consequently it does not appear that necrotic cortical bone of the fracture ends can be an important source of mineral to be used for calcification in the fracture callus.

The Blood Calcium and Phosphorus During the Period of Spontaneous Calcification of the Callus

Between the tenth and twenty-second day of healing, when spontaneous calcification of the callus may be expected in rachitic fractures, the levels of the serum calcium and phosphorus do not vary more than within the limits of error of the chemical methods of determination. However, detailed studies upon the effect of a fracture of bone on the serum calcium and phosphorus in laboratory animals and human beings, and on the metabolism of nitrogen, potassium, sodium, sulphur, sulphate, phosphorus, phosphate, creatine, and creatinine in the rat¹⁰ have shown various changes in the concentration of these elements in the blood and urine, but the author is unable to correlate them with the course of spontaneous calcification. These changes which seem to be part of the reaction of the body as a whole to injury¹⁰ become pronounced within the first six days of healing, whereas spontaneous calcification is an event of the later stages of the healing.

The majority of investigators^{5, 11, 16, 23, 27, 30, 31, 36} have found a rise in the level of the serum phosphorus of one to two milligrams per 100 cubic centimeters in clinical and experimental fractures, usually during the first week of healing, and little or no change^{5, 23, 27, 30} in the level of the serum calcium, but there are also recent reports that the serum calcium is elevated during the progress of bone formation in the callus^{3, 28, 35}. The latter have not, however, presented data sufficient to show that the magnitude of the change in the serum calcium is greater than the normal range of nine and five-tenths to eleven and five-tenths milligrams per 100 cubic centimeters of blood, or that the observations differ from those reported by others^{5, 23, 31} and regarded as irregular variations to which no significance can be attached^{27, 30}.

Local Introduction of Bone Minerals into the Fracture Area

There is an extensive literature on attempts to influence the healing of fractures by the local introduction of bone minerals. Although not always recognized, at least three questions are implied by these experiments: Is bone mineral, locally introduced, (1) a stimulus to the initiation

of osteogenesis; (2) is it a stimulus to the rate of osteogenesis; and (3) is such bone mineral used in the calcification of the callus?

The author has already considered the question of the influence of calcium salts on the initiation of osteogenesis, concluding that the formation of osseous tissues in the callus is not dependent upon the presence of such salts. Experiments on local introduction of calcium salts into the fracture area have contributed little to this aspect of the problem, as these experiments have been chiefly concerned with end results. The problem of ununited fractures is not under consideration here.

On the one hand ^{1, 4, 17, 24, 25, 32, 34} it is contended that local introduction of various calcium salts, in solution or in suspension, or in the form of devitalized bone, influences the healing of fractures favorably, as determined in various ways. Similar experiments, by other investigators ^{6, 19, 20, 33} have led to opposite conclusions. From none of these experiments is it possible to give categorical answers to the question of the osteogenic effect of implanted bone mineral, and, as Shands states, the positive results do "not prove that the calcium is actually used in the calcification of the bone matrix".

The experiments upon local introduction of bone salt presented in this paper, performed in the presence of osteogenesis following fractures, and proceeding at what may be assumed to be a maximum rate, can give no answer to questions concerning the influence of calcium salt on osteogenesis. They do, however, give some information concerning the availability of salts so introduced in the calcification of osseous tissue, this information being chiefly of a negative character.

The author has found that local injections of colloidal calcium phosphate or implantations of devitalized bone do not initiate calcification in the osteoid of the rachitic callus, a tissue which is readily calcified either by local transfer of bone salt, or by minerals transported by the blood. As also found by Eden, and as described by Huggins, McCarroll, and Blockson, the author has observed that implanted or injected mineral substances produce inflammatory changes and foreign-body reactions in the tissues, and that encapsulation and absorption follow throughout the first twenty days of healing. As is not the case in the resorption of living bone, where in association with osteoclast formation the bone salt and the bone matrix are resorbed at the same instant, the implanted dead bone is often decalcified in advance of its disintegration or autolysis. The dead bone or calcium salts appear to be dissolved in the tissue fluids without influence upon the osteoid or cartilage lying outside the fibrous connective tissue in which it was encased. These results lead to the conclusion that the introduction of inert mineral substances or dead bone does not influence calcification locally. It may be assumed either that local transfer is prevented by chemical conditions within the foreign-body reaction which develops around these substances, or that mobilization of the bone salt in chemical state suitable for local redeposition is a function of the living bone cells.

The Significance of Local Transfer of Bone Salt in the Healing of Fractures

The experimental findings presented have excluded the local transfer of bone salt as the stimulus to the initiation of osteogenesis following experimental fractures, and has found no evidence that it influences the rate of bone formation in the callus, except in so far as has previously been shown³⁹ that the orderly processes of replacement of the fibrocartilaginous callus by osseous tissues are in part dependent upon the concurrent calcification of this tissue. It has been shown, however, that local transfer of mineral from living bone to callus does occur, and some attempt to evaluate the importance of this process in the healing of fractures seems desirable.

It has been repeatedly reported that union of fractures, in both clinical^{8, 14, 21, 24} and experimental^{13, 29} rickets occurs spontaneously, although with considerable delay, and often with some deficiency in the mechanical strength of the fracture site. The development of calcification in the callus in rickets, a condition in which calcium deposition fails to take place in all other sites of new-bone formation, can be explained chiefly, if not entirely, on the basis of the local transfer of mineral. Thus local transfer of bone salt is responsible for the calcifying of the callus under conditions adverse to calcification of the skeleton in general. Under moderate conditions of mineral deficiency, under depressed conditions of mineral metabolism as in old age, or under extraordinary demand for new bone and bone salt as in cases of multiple fractures, the increment of calcium salt supplied to the callus by local transfer may be necessary for the achievement of the normal rate of calcification.

Of more general interest is the rôle of this local mechanism in the healing of fractures under normal conditions of mineral and vitamin intake, particularly in view of the widely accepted statement of Murray²⁶ that "the effective source of calcification for callus in the primary healing process following fracture is the traumatized bone at the site of the fracture". The author's view, as supported by evidence reported here and previously^{38, 39}, differs sharply from Murray's and that adopted by others^{7, 15}. Briefly stated, the author's view is that while local transfer of bone salt occurs, it is chiefly from the living shaft, rather than from necrotic bone; that it occurs only after the portions of the shaft adjacent to the fracture have become enclosed in callus; and that the capacity of this mechanism is too limited to be the "effective source of calcification" of the callus. The same mechanism by which growing bone is calcified, and by which the ordinary wear and tear of bone is compensated for—that is, the humoral transport of bone mineral—is of far greater importance in the healing of fractures in normal individuals under normal conditions of mineral intake.

It is true that this conclusion is based largely upon experiments upon rachitic animals, and that the objection may be raised that the capacity of the mechanism of local transfer of bone salt in such animals does not necessarily reflect the capacity of the similar mechanisms in animals with

normally calcified bones. While this objection has some slight validity, the density of calcification of the fractured shafts of the bones of the rachitic animals is not sufficiently less than that of the shafts from normal animals to permit the belief that the general conclusions are materially altered by the nature of the experimental material.

It is well known that the inorganic-phosphate concentration of the plasma in the adult is considerably below that of the infant, and is so low that it is difficult to account for the calcification of bone in the adult on the basis of the solubility of the phosphates of calcium. Moreover, reports on the calcium and phosphate levels in the plasma of adult individuals with healing fractures are conflicting, but do not lead to the conclusion that increased concentrations of these substances in the plasma are essential to normal calcification in the callus. It is conceivable, although not demonstrated, that the resorption of the callus-enclosed shaft, with diffusion of the dissolved or colloidal calcium salt into the fracture callus, may assist in raising the local concentrations of the ions of the bone mineral to such an extent as to aid in precipitating the mineral ions transported in the blood. This interpretation is suggested by the observations that calcification advances centrifugally to a sharp line which is parallel to the periosteal blood supply (Figs. 2 and 3). Thus transfer of bone salt, increasing the local concentration of calcium and phosphate ion, may *determine* and delimit the site of calcification; the source of the bone mineral, however, must be chiefly humoral.

SUMMARY

1. Spontaneous calcification of the rachitic callus in the later stages of healing has been described in detail, and has been shown to be responsible for the consolidation of fracture in rickets.

2. Spontaneous calcification of the callus has been defined, on the basis of observations upon the blood calcium and phosphorus, and upon undecalcified histological specimens which demonstrate the bone salt, as calcification which is progressive and limited to the fracture area. It is not accompanied by any change in the levels of the blood calcium and phosphorus, or in the existing state of the rachitic metaphyses. The calcium salts are laid down in the osteoid and cartilage of the tissues adjacent to the shaft in a characteristic pattern which is clearly distinguishable from calcification which follows administration of phosphate solution or vitamin D, and results in healing of the rickets.

3. The necrotic and uninjured portions of the section of the shaft which is enclosed in the growing callus have each been considered as possible sources of the calcium salts deposited in spontaneous calcification of the callus. The fact that the living cortical bone, by far the greatest portion of the length of the shaft enveloped in callus, becomes considerably rarefied when the callus reaches maximum size, and at the time when spontaneous calcification reaches its maximum distribution, suggests that this calcification represents local transfer of calcium salts from the

shaft to the callus. Since the necrotic portion of the section of the shaft surrounded by callus is only a small fraction of the bone mineral stored in the cortex at the fracture area, it is believed that if it contributes to local transfer in the course of its absorption, the amount of bone salt thus liberated is relatively insignificant and cannot be regarded as an important source of the calcium salts deposited in the callus of healing fractures.

4. Because local implantations of devitalized bone or injections of colloidal calcium phosphate into the rachitic callus osteoid, prior to the advent of spontaneous calcification, fail to initiate calcification, it is concluded that these substances cannot be regarded as local sources of the bone salt. The differences in the mechanism of the resorption of living bone, as compared with the process of the absorption of dead bone or calcium salts, suggest that the local redistribution of the bone salts in the area of a healing fracture is brought about by the activity of the cellular elements of the bone, possibly the osteoclasts.

5. The phenomenon of local transfer of calcium salt may be regarded as indirect experimental evidence of local increase in concentration of dissolved calcium salt in the extracellular fluid of living bone undergoing resorption.

CONCLUSIONS

The rôle of local transfer of calcium salt from shaft to new bone in the healing of fractures is considered that of a reserve mechanism which aids in consolidating callus under conditions adverse to calcification of the skeleton in general. The humoral source of bone salt is essential for the normal progress of healing, and cannot be entirely replaced by local sources of mineral without considerable delay in the uniting of fractures. Resorption of cortical bone, the process leading to local transfer of bone salt, does not appear until the later stages of healing, does not progress at a rate parallel to osteogenesis, and fails to supply the quantity of mineral needed to calcify the existing callus at any one time. Bone salt originating locally in necrotic bone or implanted in the callus is absorbed without influence upon the progress of calcification of the new bone and cartilage matrix.

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THE CLINICAL SIGNIFICANCE OF CERTAIN MICROSCOPIC CHANGES IN MUSCLES OF ANTERIOR POLIOMYELITIS *

BY HERBERT E. HIPPS, M.D., F.A.C.S., MARLIN, TEXAS

From the Crippled Children Hospital, Marlin

The pathological changes which occur in the muscles of anterior poliomyelitis have received very little study. The gross changes have been entirely neglected until recently¹⁴, and the work^{2, 12, 13, 17, 26} that formerly had been done on the microscopic changes was largely of a descriptive nature.

It is only natural that muscle function and muscle pathology should be closely interrelated. This was found true in the investigation of the gross pathological changes, and likewise should be largely true in the microscopic study. Since this study was made on living muscles in living patients and the actual strength and condition of the muscles was known, it was possible to correlate certain microscopic findings with certain types of muscle behavior.

Obviously it is fallacious to try to analyze the complete behavior of any one muscle from the microscopic appearance of one or two tiny sections from that muscle; yet certain generalizations on muscle function and microscopic appearance can be pointed out and acceptably entertained.

It is the purpose of this paper to describe certain of these interesting microscopic findings, and to analyze these findings in the light of muscle behavior.

METHOD OF STUDY

This study was made on patients who had had the disease two years or more. The muscles were carefully studied, graded, and often given physiotherapy for varying periods of time before the operation. Some standard operation that the patient needed was done. The incision, however, was lengthened enough so that in nearly every case the full muscle was visualized. Sections for microscopic study were removed from the most damaged part of each muscle.

Grossly the muscle shown in Figure 1 (P. R.) was rather homogeneously involved. The history indicated an early complete paralysis. Some return in contractile power occurred in the next few weeks. During the subsequent year a slight progressive increase in strength occurred. For several months it had remained at this stage, much improved over its original postparalytic strength, but not normal. It had apparently reached a definite standstill in its ability to gain more strength.

This section shows three interesting things often found in poliomye-

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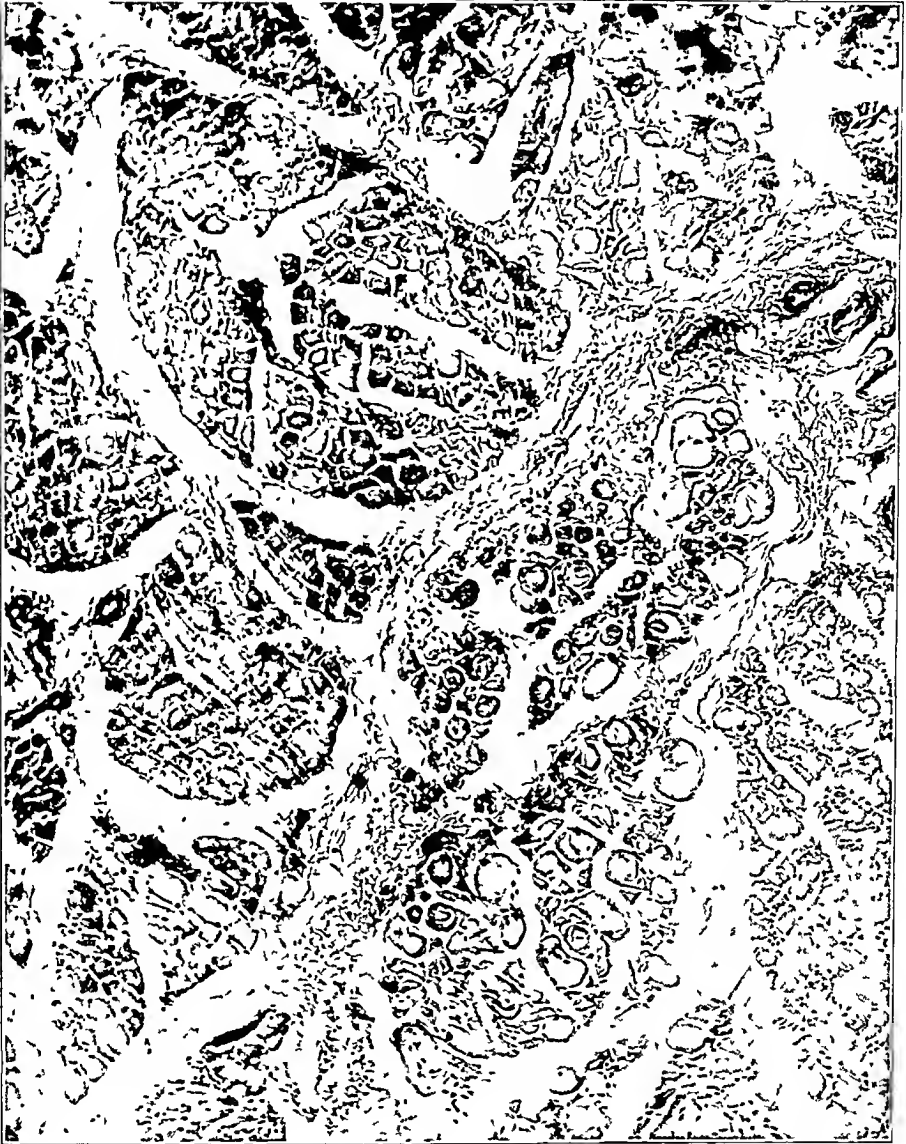


FIG. 1

P. R Muscle grade was poor plus. Photomicrograph ($\times 1000$) shows the decreased number of cells in the bundles near the center, the increased interfascicular fibrosis about the involved bundles, and the large round hypertrophied cells in bundles containing a lessened number of cells.

litic muscle. There is increased interfascicular fibrosis; this is present only around those bundles which have been damaged, and does not fill in the interspaces between normal-appearing bundles. There is atrophy and disintegration occurring in many cells; only a cellular debris remains in some places. The most interesting finding, however, is the large round cells. They are present only in those bundles which also contain the atrophic and disappearing cells; they do not occur in normal bundles. They appear to be perfectly normal, and they stain with van Gieson stain

entering the muscle, it breaks up into many collaterals which, in the mammalian limb, supply from 100 to 160 fibers. The motor neuron, with the regiment of muscle cells it supplies, is called a "motor unit". It is easy, therefore, to see that the destruction of a single anterior-horn cell will put out of commission a small group of muscle cells. If one anterior-horn cell were destroyed and its immediately adjacent anterior-horn cell were not involved, then one would expect to find in the muscle a patch of relatively normal cells. Such is the picture presented in Figures 1, 2, 3, 6, and 7.

Figure 2 (N. O. N.) shows fairly good-looking muscle cells below, while at the top of the picture there are cells undergoing a marked degree of atrophy. Note here the diminished size of the cells, in some areas beginning granular change, and the apparent increased number of muscle nuclei, which is a typical picture of cellular atrophy in a moderately advanced stage.

Figure 3 (E. S.) shows relatively normal-looking muscle cells below, but above there is a patch which is being replaced with fibrous tissue. These cells in the upper group have already undergone the changes of atrophy and degeneration, and the fibrous replacement change is now present.

These photomicrographs probably represent the most common finding in poliomyelitic muscles. The explanation is, of course, that certain "motor units" are involved whereas others are not, and this seems to be the rule rather than the exception in poliomyelitic muscles.

Figure 4 (B. F. D.) shows a cross section of a muscle from a child whose history indicated an immediate, complete paralysis with not one degree of function ever recurring in the muscle. The muscle immediately became atrophied and thin, and never during the course of the three-year period following the paralysis did it ever regain any strength or contractile power. Gross examination of this muscle found a uniform fibrous-replacement change throughout.

The microscopic changes noted in Figure 4 show a most marked degree of muscle replacement of the fibrous type. There are a few muscle cells remaining, but they are exceedingly small and atrophic. There is a great increase in interfascicular fibrosis, and fibrous replacement is occurring in the bundles themselves. This picture represents the complete end stage of fibrous replacement in a muscle completely paralyzed. This child's muscle in all probability could never gain in strength because of the apparently complete degree of motor-neuron involvement, and it could not be hoped that treatment of any kind would bring back this muscle's contractile power.

Figure 5 (V. M. S.) is of a section removed from a tibialis anterior in a child whose only residual involvement following an attack of infantile paralysis was a slight equinus and a stretched-out tibialis anterior that graded "fair plus".

The muscle grossly showed almost normal-appearing cells in the



FIG. 4

B. F. D. Muscle grade was zero. Photomicrograph ($\times 1000$) shows stage of complete fibrous replacement,—an end stage in the atrophic, degenerative, replacement process that occurs in a poliomyelitic muscle. A few small atrophic muscle cells can be found, but these are few in number.

upper two-thirds of its belly, but at the musculotendinous junction there was a zone of pale grayish-pink muscle which did not have the contractile power of the upper segment. The microsection is from the lower grayish-pink zone.

This is a most interesting section, as it is a picture also frequently seen in poliomyelitic muscle. This is a zone of fibrosis cutting across muscle cells on longitudinal section and thus interrupting their continuity.

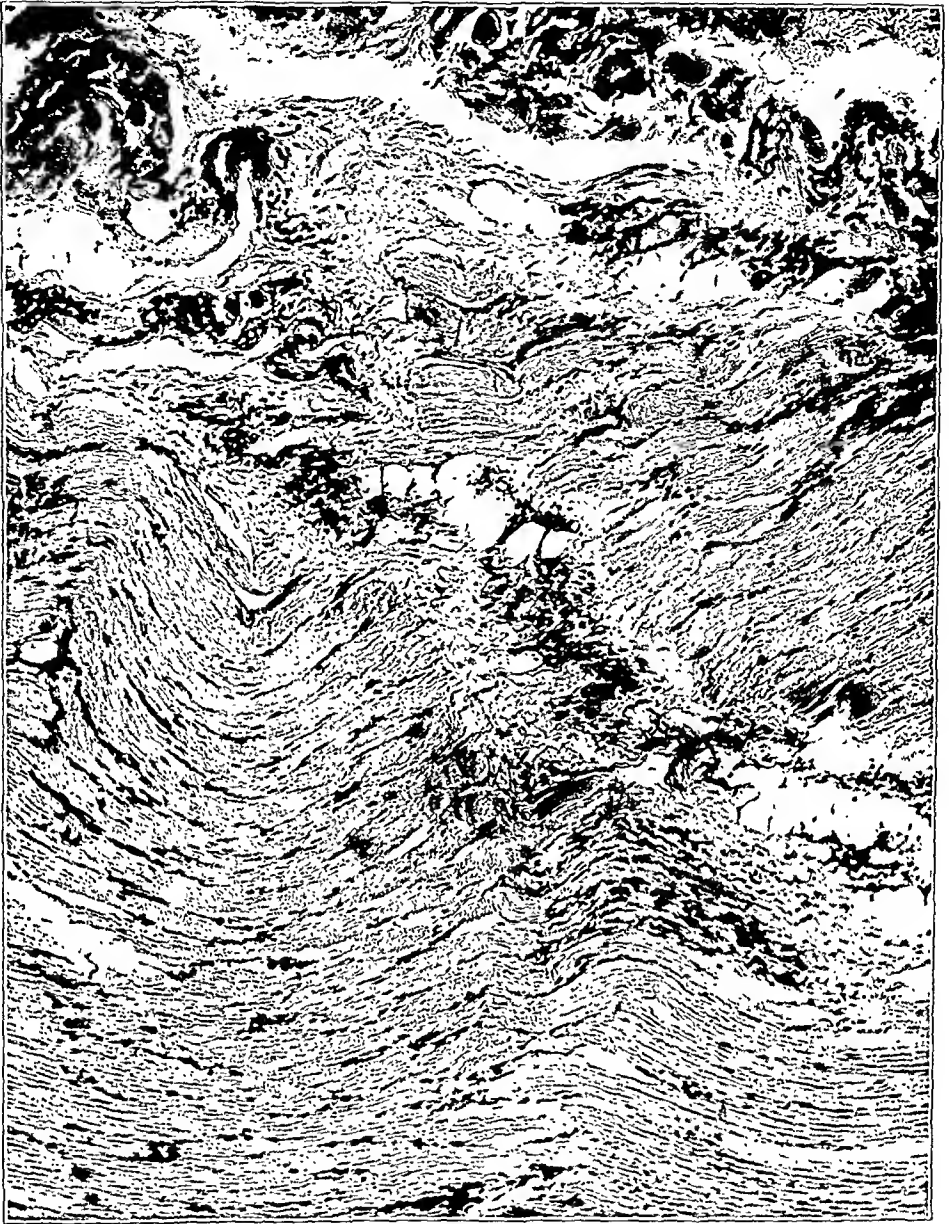


FIG. 5

V. M. S. Muscle grade was fair plus. Photomicrograph ($\times 1000$) shows zone of fibrosis cutting directly across fairly good-looking muscle cells. This is not interfascicular fibrosis. This zone probably interferes with the flow of contraction through the muscle.

Obviously this is not interfascicular fibrosis, as it cuts directly across muscle cells. It is, therefore, most likely that a minute tear or rupture has occurred in the muscle at this point and fibrous tissue has filled in along that zone. There is no other explanation for its presence that is at all reasonable.

Since this photomicrograph is of a section from the most damaged part of a stretched-out muscle, it seems most reasonable to assume that this pic-

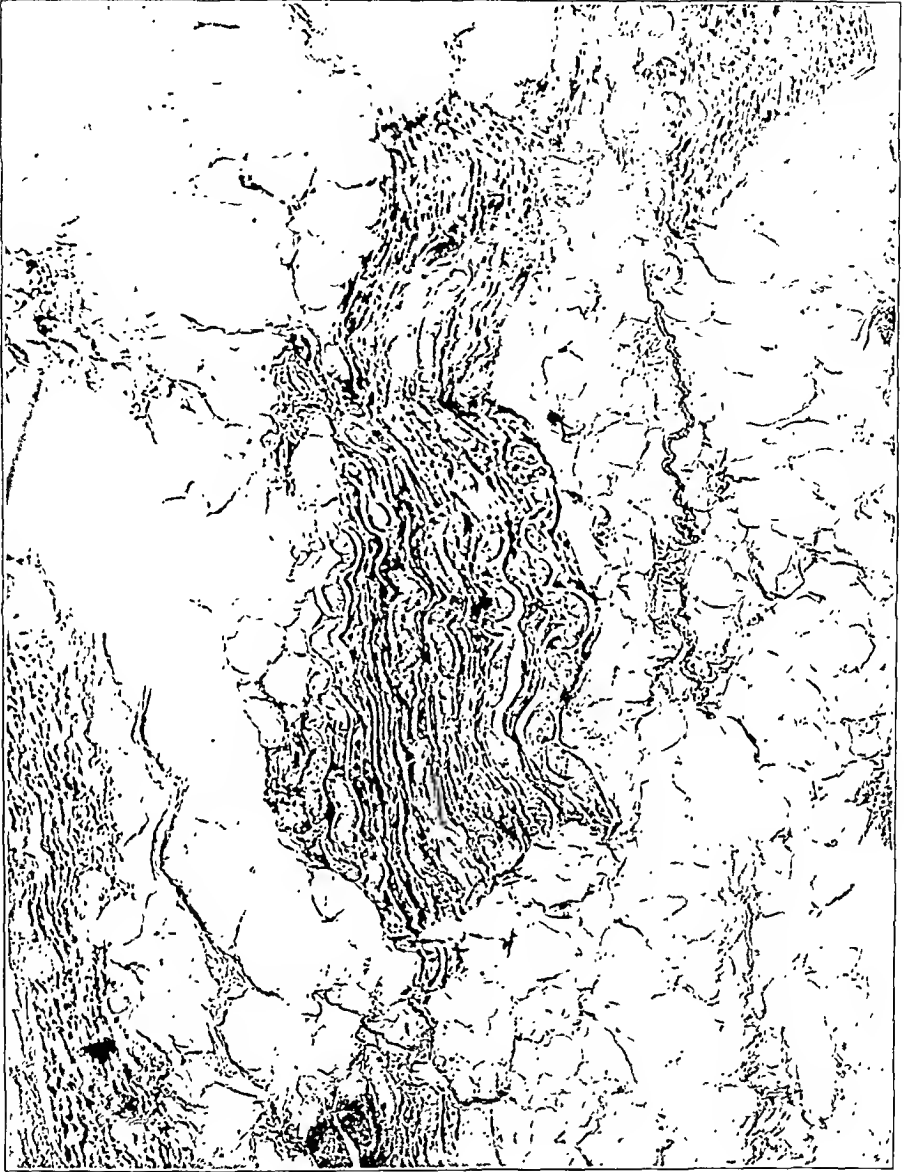


FIG. 6

M. M. Muscle grade was zero. Photomicrograph ($\times 1000$) shows muscle that is being completely replaced by fatty tissue. This also is an end stage, but the replacement tissue is predominantly fatty instead of fibrous. The cells of this island are undergoing various degenerative changes. Note the swollen fibers that show the mealy, waxy change of beginning disintegration.

ture represents what may happen to a poliomyelitic muscle when subjected to a too great and too prolonged stretch. This zone then is a "stretch tear" which occurred in multiple areas through the lower zone of the muscle. No gross, sudden, severe injury or rupture occurred, but the slow, continued stretch force produced multiple microscopic tears in the muscle.

Naturally the presence of these transverse zones of scar tissue weaken a muscle. They, themselves, delay the flowing wave of contraction

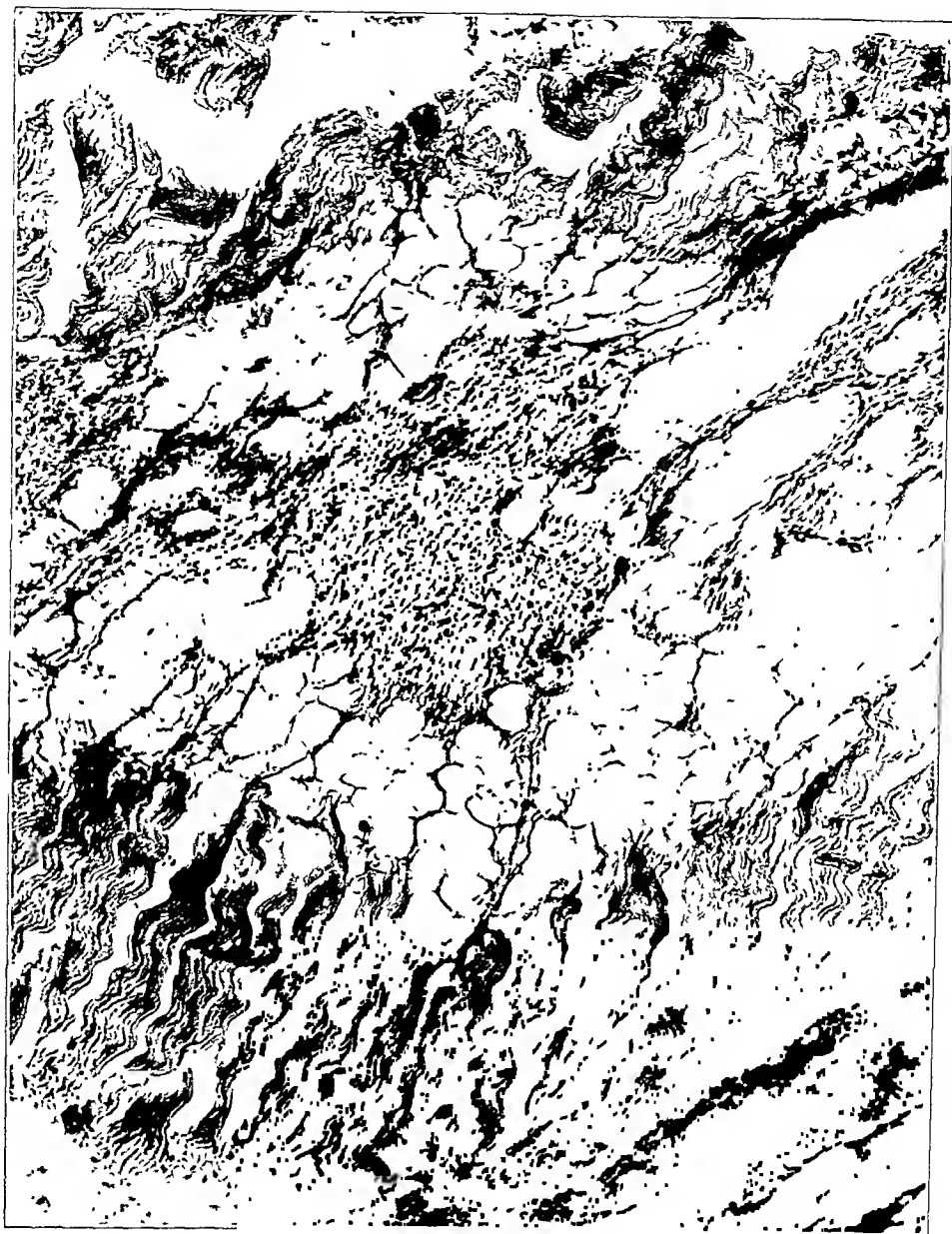


FIG. 7

B. R. G. Muscle grade was poor. Photomicrograph ($\times 1000$) shows muscle island surrounded by fatty change. Note the fat cells replacing muscle fibers. In some places fat-cell nuclei (signet-ring appearance) can be seen. The cells in the island are undergoing atrophy, and a few are showing beginning hyalinization.

through the muscle, and the original tear damaged not only the muscle cells directly torn, but also, axon collaterals to other cells beyond the damaged zone.

This illustration, therefore, rather concretely shows one of the *secondarily* induced pathological changes which may occur in muscle after the acute paralysis is over, and reemphasizes the clinical importance of preventing a stretch of involved muscles.

It is also probable that the occurrence of such things as this will ex-

plain the continued soreness and tenderness in some poliomyelitic muscles long after the acute stage is over.

Figures 6 (M. M.) and 7 (B. R. G.) are sections similar, in that minute muscle islands remain in a sea of fat. Both muscles are extremely weak, and pathologically show an end stage of fatty-replacement change.

The most logical explanation for the presence of muscle islands like these is that they represent intact "motor units". It is not so likely that they are more hardy cells which thus far have survived the degenerative, disintegrative, and replacement changes that progressively occur in denervated muscle.

Previous work^{2, 3, 4, 5, 9, 10, 15, 20, 22, 24, 25} on denervated muscle, experimentally produced, has always found a rather uniform or homogeneous degree of pathological change throughout all parts of the involved muscle. Since this has not occurred here, and these muscles have been paralyzed for a sufficiently long period of time, it is most likely that this represents a remaining "motor unit".

There are, however, pathological changes occurring in these island cells, but of a very much earlier stage. These latter changes, therefore, must be changes secondarily induced.

Since this is most likely true, then an analysis of the physiological status of these islands should lead to some positive information in regard to these secondary changes—why they develop, their progress, and perhaps point out some way of preventing their occurrence.

Physiologists have long demonstrated that a muscle remains, even in its relaxed, resting state, in a constant tension^{19, 23}. This tension is absolutely necessary for the proper function of that muscle; and if that tension is lost, the muscle cannot function at all. It cannot contract, since it has already contracted maximally and the fibers are as short as they can possibly be. This, of course, induces a complete and unnatural rest or state of disuse in the muscle, which, as many authors have shown, causes a severe degree of atrophy to occur.

Lippmann and Selig showed that the degree of atrophy in a muscle following tendon section was most complete, and of about the same degree as the atrophy of denervation. The cells in the muscle islands are in the same physiological status as those of a muscle completely relaxed by having its tendon cut. These cells remained stretched-out in their normal tension for some time following the paralysis,—being held so, by the surrounding, still intact, but denervated muscle cells. Atrophy and disintegrative changes, however, occurred in these surrounding cells due to the denervation, and fatty tissue replaced them. This fatty tissue, being loose and flaccid and surrounding these islands, did not maintain the tension necessary for normal function in those island cells. They, therefore, gradually contracted as fatty replacement occurred, and now they are in a stage of complete disuse, just as is a muscle with its tendon completely cut; hence atrophy and subsequent degenerative changes are occurring. These are, therefore, *secondarily* induced changes, due to the position and

tension status of the island cells and not due to involvement of the anterior-horn cells.

In these muscles (Figs. 6 and 7), therefore, two different groups of pathological events are occurring. The primary or initial chain of events is due to denervation and is almost completed. Muscle cells following denervation underwent atrophy, degeneration, and disintegration; and then fatty replacement occurred. Remaining uninvolved "motor units" are affected also by the loss of these denervated cells, since the tension status of the remaining cells is altered. This change in tension, which is so important a part of normal muscle function, thus induces secondary pathological changes in the remaining cells.

The final weakness or strength of an involved muscle, then, is the summation of these two pathological processes.

A general comparison of the sections from all the ninety-four examined muscles was made. This revealed the following:

1. The age of the patient seems to have no bearing on the microscopic picture of any muscle.
2. The muscles showing fatty-replacement changes are uniformly weaker muscles than those showing fibrous-replacement changes.
3. Fifty per cent. of the muscles examined showed cellular hypertrophy in involved bundles.
4. Sections showing cellular hypertrophy almost invariably were from muscles grading "poor" or better. Only one graded "trace" and none "zero".
5. No newly formed or regenerating muscle cells were found in any section.

Some authors ^{12, 16, 17} in writing on poliomyelitis have mentioned the presence of newly formed muscle cells. They explain a gain in muscle strength through cellular regeneration.

A careful thorough study of every section from every muscle was made, and it failed completely in finding any evidence of new muscle cells. Sections from the muscles of very young children, in whom an actual regrowth of new muscle might be most reasonably expected to occur, if it could occur at all, failed completely in locating anything resembling newly formed or regenerating cells.

It seems, therefore, that physiotherapy and exercise can only conserve and develop the strength in the remaining cells of a partially paralyzed muscle, and cannot increase strength by inducing new cells to form.

The early treatment which the involved muscles received in each case was reviewed. This revealed the interesting fact that those muscles showing fatty change were muscles which had been immobilized or not used for long periods of time. Muscles showing a predominance of fibrous change were in patients who had tried to walk or stand early or had exercised their muscles vigorously.

Naturally, conclusions drawn from this observation cannot be scientifically correct, because of so many unknown and interrelating

factors in each case; yet, it does suggest that prolonged inactivity is harmful and probably induces fatty-replacement change following the atrophy of disuse. Since muscles showing fatty change are uniformly weaker than those showing fibrous change, it seems logical to theorize that prolonged inactivity does more harm to a muscle than too vigorous activity.

GENERAL DISCUSSION AND CONCLUSIONS

Microscopic evidence seems to indicate rather conclusively that a gain in strength by a partially paralyzed poliomyelitic muscle does not occur through the formation of new muscle fibers, but through an overdevelopment or hypertrophy of remaining undamaged cells.

Pathological changes occurring in muscle following acute anterior poliomyelitis are brought on in two ways:

1. *Primarily*, through denervation.
2. *Secondarily*, from abnormal variations of tension in the muscle.

The cellular changes from denervation begin with atrophy and progress to degeneration, disintegration, and replacement changes. These same pathological stages occur in muscle cells in exactly the same way, due to secondary factors. Too much tension or overstretching results in minute tears, zonal degeneration, and subsequent fibrosis; while too little tension produces changes identical with denervation, and the rate of change is nearly as fast. These secondary abnormalities may produce just as much weakness in a muscle as the primary denervation changes.

Secondary changes following immobility and disuse seem to be more severe than those following overactivity.

Obviously, there is nothing much that can be done for muscle cells which have lost their motor neurons and have undergone or are undergoing these regressive changes. Something might be done, however, about the secondary changes which occur.

The knowledge, therefore, that these secondary changes do occur and how they occur should be of some practical value in planning treatment for postpoliomyelitic muscles.

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THE USE OF PRESERVED BONE GRAFT IN ORTHOPAEDIC SURGERY [†]

BY ALBERTO INCLAN, M.D., HAVANA, CUBA

Two years ago, the author had the honor of presenting to this Academy a preliminary report [†] on his personal experience with the use, for grafting purposes, of homologous and autogenous bone, preserved in citrated blood and kept under refrigeration, especially as a surgical aid in the treatment of ununited fractures of the neck of the femur

Since that date, he has been using this procedure in those patients in whom the operative risk was so high that bone-grafting performed in a single operation would considerably endanger the life of the patient, or in those in whom it was thought inadvisable to use autogenous bone because of the extreme difficulty in its acquirement, the risk of infection, or the poor osteogenetic power of the bone which was obtainable

Thirty-six patients are now reported in whom the author has used refrigerated bone as grafting material. Through the courtesy of Dr P Sanchez Toledo, it is possible to add sixteen more cases which were treated by him according to this technique, making the total number of cases reported fifty-two.

In forty-three of the patients operated upon, the graft was obtained from the same patient; in eight patients, homologous bone obtained from a donor was used; and in one, bone from a nine-months foetus was employed.

The conditions for which preserved bone grafts have been used are shown in Table I.

TABLE I
CONDITIONS FOR WHICH PRESERVED BONE GRAFTS HAVE BEEN USED

	No. of Cases
Blocking of paralytic foot	3
Ununited fracture of the patella	1
Ununited fracture of the neck of the femur	12
Spine fusion (Pott's disease)	16
Pathological fracture of the neck of the femur (bone cyst)	1
Recent fracture of the neck of the femur	8
Paralytic scoliosis	4
Platyspondylisis	1
Idiopathic progressive scoliosis	4
Spondylolisthesis	1
Epiphysitis of the femoral head	1
Total	52

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons at New Orleans, Louisiana, January 15, 1941.

[†] Not published.

Different types of grafts which have been used to comply with the purpose of the operation are given in Table II.

TABLE II
TYPE OF GRAFT

	No of Cases
Massive solid	36
Osteoperiosteal	1
Mixed, solid, and osteoperiosteal	13
Epiphyseal	1
Foetal massive	1
Total	<u>52</u>

The source of the graft is shown in Table III.

TABLE III
SOURCE OF GRAFT

	No of Cases
Humerus	1
Tibia .	45
Fibula	2
Ribs	1
Head of the astragalus	2
Femur and tibia (foetal)	1
Total	<u>52</u>

The bone obtained for grafting purposes has been preserved by placing it in a sterilized glass container, covering it well with citrated blood from the patient or from a donor of the same blood group, and immediately placing it in a refrigerator at a temperature fluctuating between 2 and 5 degrees centigrade. In some cases, normal saline solution, or saline solution to which has been added a small amount of blood from the patient, has been used for this purpose

TABLE IV
FORM OF PRESERVATION

	No. of Cases
Citrated blood	34
Saline solution	1
Saline solution and blood	17
Total	<u>52</u>

The time period in which the graft has been preserved has varied in accordance with the circumstances of each case.

The possibilities of autogenous and homologous bone transplantation have been known for years, and the author has profited from the experience and magnificent work of such men as Murphy, Lexer, Carrel, Albee, Delbet, Tuffier, Haas, and many others, who by their experimental and clinical work have argued and proved the superiority of the autogenous bone graft over the homologous and heterologous transplant. The author agrees entirely with the generally recognized superiority of autogenous bone.

In some cases, however, autogenous bone is difficult or impossible to obtain, and even homologous bone at times is not obtainable from a living

subject at the moment at which it is needed. When large massive transplants are necessary in order to perform both operations at the same time, they are very seldom obtainable. Lexer in his transplantations used amputated limbs while "still warm", but in very few instances can a surgeon find a freshly amputated limb.

TABLE V
TIME PERIOD OF PRESERVATION OF BONE GRAFTS

3 days	3 cases
4 days	2 cases
5 days	1 case
7 days	15 cases
8 days	4 cases
10 days	4 cases
12 days	2 cases
14 days	9 cases
15 days	3 cases
18 days	3 cases
19 days	1 case
21 days	2 cases
24 days	1 case
35 days	1 case
63 days	1 case
Total	<u>52</u>

There are reported in the literature rare instances of successful homoplastic bone transplantations, as in the cases reported by Ellmer and Schmincke, Calvé, Leriche, and others, and even transplantations of joints by Lexer, Meyer, and others. There have often been reports of bone transplanted from mother to son, or from brother to brother. On the other hand there have also been failures following the use of homoplastic bone and of cadaver bone as a transplant.

Until recently, because of difficulties created by sentimental and religious prejudice, it has been impossible to obtain bone for preservation from fresh cadavera. On one occasion the author was able to use preserved foetal bone for spine fusion in a small child. However, the experimental and clinical work of Carrel, Tuffier, Lexer, and others, on the viability of bone and other tissues obtained from the fresh cadaver and refrigerated for varying periods of time, and the work of Youdine and other Russian investigators concerning the use of cadaver blood for transfusion indicate that the acquirement and preservation of such bone and its use for grafting purposes is feasible.

TECHNIQUE

For the last six years, the author has used autogenous or homologous preserved bone for grafting purposes. This has been obtained aseptically through a surgical operation, and kept well covered and surrounded by citrated blood of the patient or donor, refrigerated at an average temperature of 37 to 40 degrees Fahrenheit, and bacteriologically controlled during the period of preservation.



FIG. 1

Histological aspect of bone twenty-one days after preservation in citrated blood under refrigeration.

To prove the viability of the bone kept under the above-mentioned conditions, some experimental work has been carried out, consisting of a number of operations performed on rabbits and dogs. These have been sufficient to prove that bone, kept under the previously described conditions, could be transplanted from one animal to another without any local or general reactions, and in those cases where primary healing was obtained, would act like any fresh autogenous bone, even though it had been kept for three weeks before being used for grafting.

The histological aspect of bone preserved under the same circumstances for different periods of time has also been studied for variations of the staining properties of the bone cells, which could indicate necrosis. The bone cells and bone tissue vary little or not at all from preparations of fresh bone. Only in places where trauma has produced sloughing or separation of the tissues and in the medullary tissue is there any necrosis.

The third and most important proof of the viability of a refrigerated bone transplant is the clinical evolution of the graft. As a convincing demonstration of the preservation of the so-much-discussed biological properties of the bone graft, the author presents as undeniable clinical facts two patients with non-union of the neck of the femur and almost complete absorption of the central portion of the neck, in whom refriger-

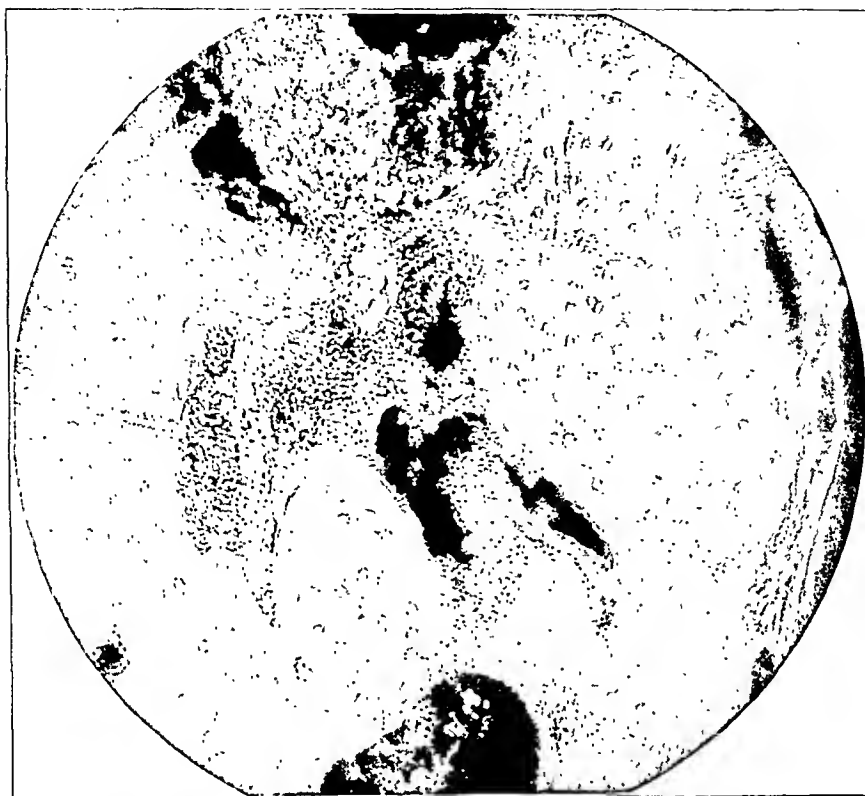


FIG. 3
Histological aspect of bone 105 days after preservation.

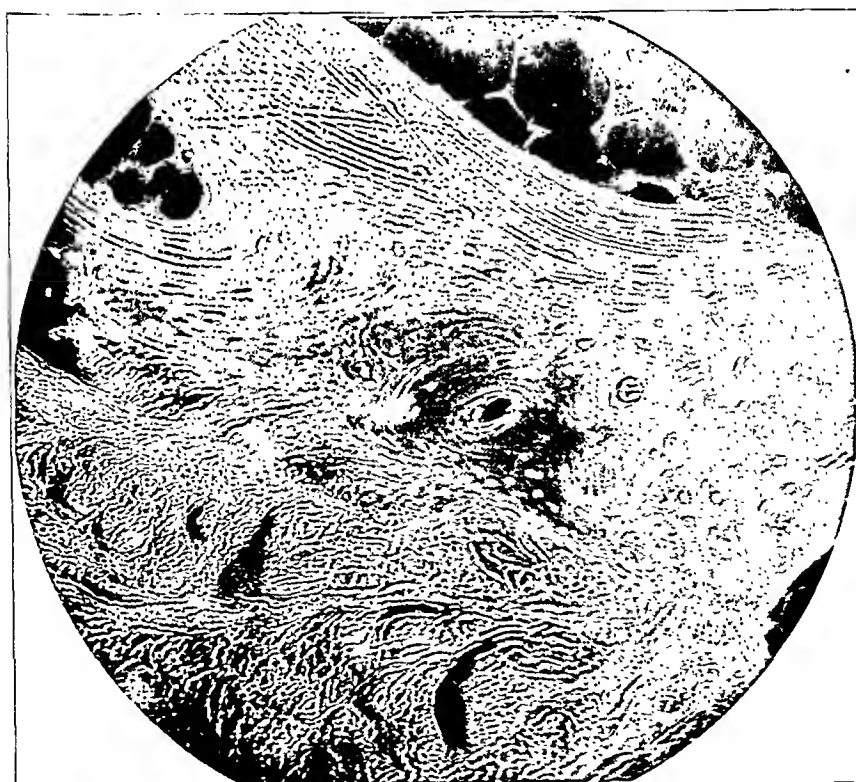


FIG. 2
Histological aspect of bone twenty-eight days after preservation.



FIG. 4-B

Case 1. Anteroposterior view after operation. Mechanical fixation with a Smith-Petersen nail. Biological treatment with refrigerated autogenous bone filling the gap between the head and the trochanteric part of the neck.



FIG. 4-A

Case 1. Old ununited fracture of the neck of the femur with marked absorption of the central portion of the neck.



FIG. 4-D



FIG. 4-C

Case 1. Anteroposterior and lateral views showing the result one year after operation. Complete restoration of the neck through the graft has taken place, but the gap persists in the upper aspect of the neck where the bone graft was not used.

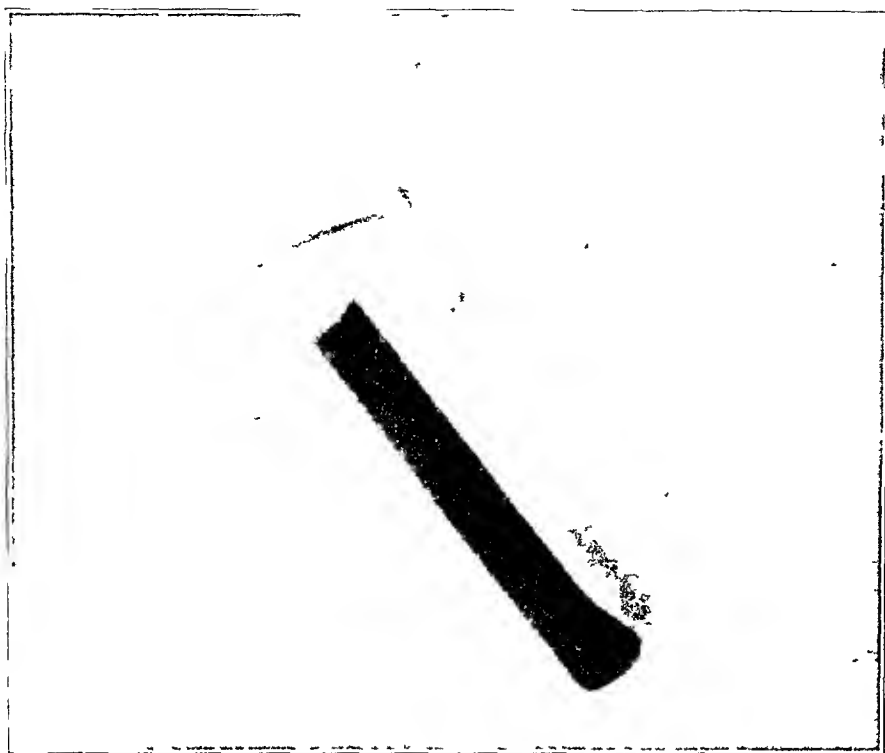


FIG. 5-B

Case 2 Mechanical fixation with a Smith-Petersen nail, and biological treatment with two autogenous bone grafts which had been kept in citiated blood under refrigeration for ten days.

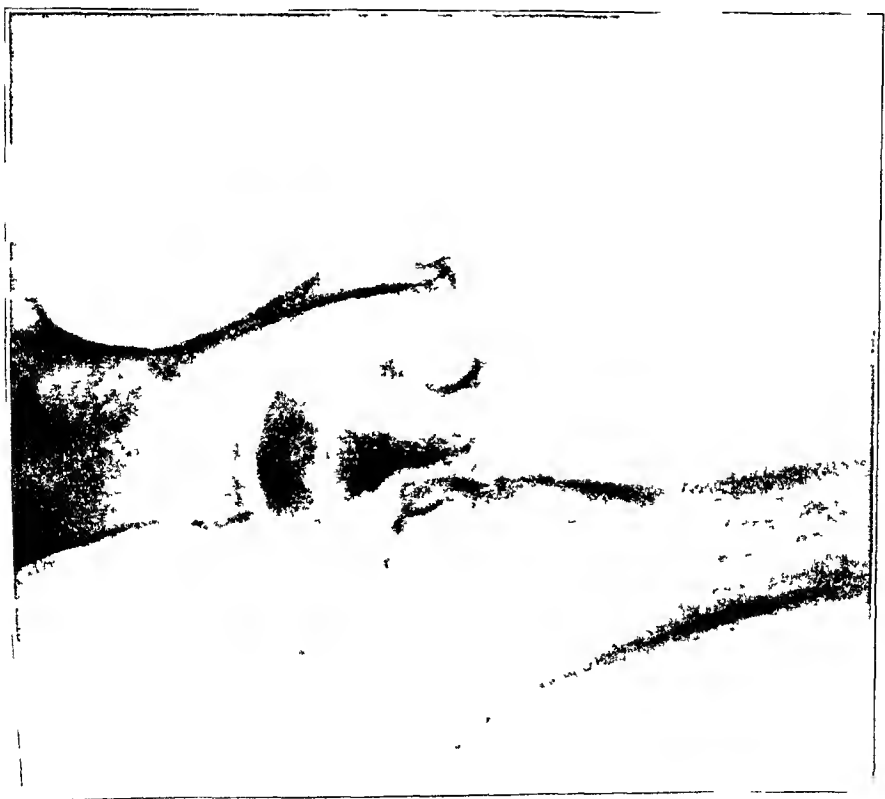


FIG. 5-A

Case 2. Ununited fracture of the neck of the femur with marked absorption.



FIG. 5-C

Case 2. Anteroposterior and lateral views showing result one year after operation. There is restoration of the neck and perfect function.

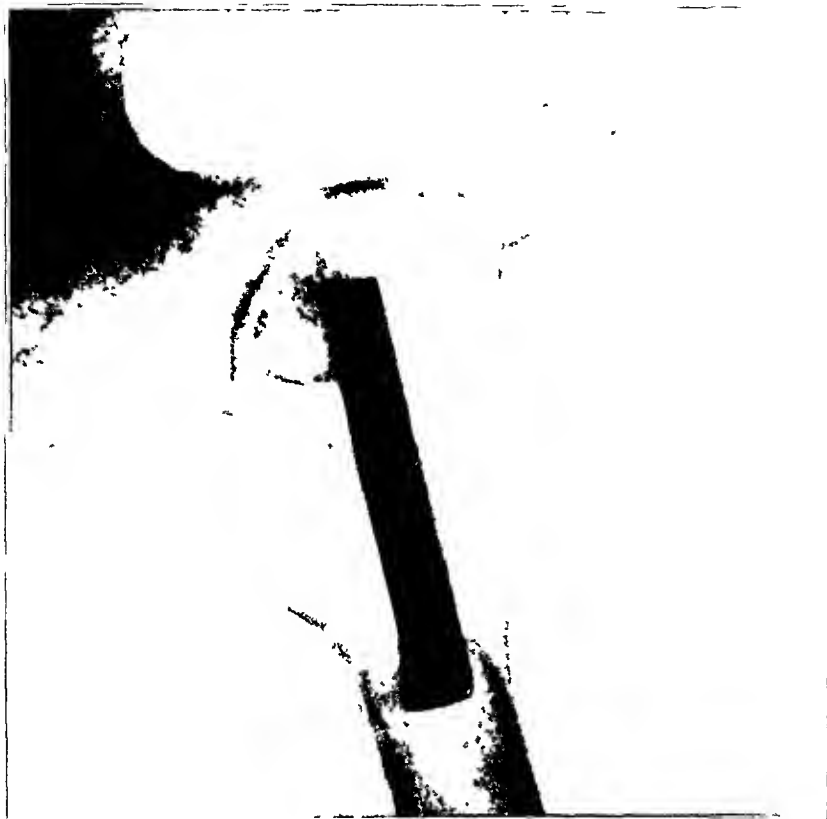


FIG. 5-D



FIG. 6

Lateral view of a postmortem specimen after a spine fusion with preserved bone.

is sufficiently satisfied with the behavior of preserved bone to recommend its use when conditions and circumstances demand.

INDICATIONS

The autogenous preserved bone graft has been reserved exclusively for patients needing bone transplants in whom the high operative risk has made the two-stage operation the method of choice. When for any special reason—such as syphilis, tuberculosis, bone atrophy due to previous immobilization of long standing, or endarteritis obliterans leading to previous amputation—the acquirement of bone from the patient could not be recommended, homologous bone obtained from a voluntary donor has been used for this purpose.

In cases of non-union of the neck of the femur, the bone-graft-peg operation originally described by Albee seems the method of choice.

ated bone grafts have been used as a bridge between the atrophic head and the trochanteric part of the neck. Clinical and roentgenographic examinations of these patients at different periods have shown that union has been obtained through the graft, and that reconstruction of the neck has resulted from new-bone formation, but only in the region where the graft was placed. A postmortem specimen (Fig.6), showed that a solid bony fusion had been obtained in a case of Pott's disease. Refrigerated bone had been employed, and had acted as any fresh transplanted bone would in an operation of this type.

As has been stated before, the preserved bone graft is not intended to displace fresh autogenous bone as the best obtainable material for grafting purposes, but the author



FIG. 7-B



FIG. 7-A

Anteroposterior and lateral views of a fracture of the neck of the femur showing the biological and mechanical treatment by the use of a four-flanged nail carrying a tunnelized bone graft. This nail has been developed by Dr. U. Sosa.



FIG. 8

Spine fusion for paralytic scoliosis with massive preserved bone graft.

patients, as a mechanical means of fixation, the Smith-Petersen nail, placed parallel and immediately above the bone graft.

The author is convinced that, in the treatment of recent fractures of the neck of the femur, the necessary restoration of the biological conditions indispensable for bone repair are not always obtained by the conservative treatment or by the surgical fixation with nails, screws, bolts, etc. For this reason, in the last group of patients with a subcapital or transcervical fracture of the neck of the femur the author has recom-

Because of the advanced age and poor general conditions prevailing in many of these patients, implantation of the bone graft and suturing of three operative wounds in a single surgical procedure has been considered by most orthopaedic surgeons a major and risky operation.

In the author's technique, bone from the tibia of such a patient is obtained, under local anaesthesia, and is preserved in the manner described for a period of from seven to fifteen days. Then in a second operation, also under local anaesthesia, the displacement of the fragments is reduced. Through a small incision in the trochanteric region the neck and head of the femur are drilled and, under roentgenographic control, the bone peg is properly implanted. There has been no mortality due to the operation in any of these cases. For this reason the author has adopted this technique for the treatment of ununited fractures of the neck of the femur, using in his last eight pa-

mended the early use of a bone graft, combined with the use of internal fixation by a Smith-Petersen nail. The bone transplant is resected under local anaesthesia, and is preserved. The patient is treated by traction in a Braun frame, and is checked by the internist before the operation is done. There has been no mortality so far in the eight patients subjected to this treatment, although two of them are close to or over ninety years of age.

In five cases of recent fracture of the neck of the femur, a special vitallium nail developed by Dr. U. Sosa, has been used. (See Figures 7-A and 7-B.) It carries a tunnelized bone graft, and aims to solve both the problem of mechanical fixation of the fracture and the biological problem of impaired circulation.

Spine fusion, for the treatment of Pott's disease or for the fixation of a previously corrected paralytic or structural scoliosis, or for any other condition of the spine in which fusion of a number of vertebrae is indicated, has been in the author's practice a procedure frequently attended by shock. This is especially true in children in whom, because of preexisting anaemia, intestinal parasites, and liver insufficiency, operations of this type are considered to be extremely dangerous. Twenty-six of the fifty-two operations were spine fusions. The necessary bone for an extensive fusion was obtained from the patient or from a donor in a previous operation under local anaesthesia. When massive solid grafts are employed, a flexible probe is molded over the spinous processes shown in a lateral roentgenogram of the spine, to give the size and shape of the grafts required.

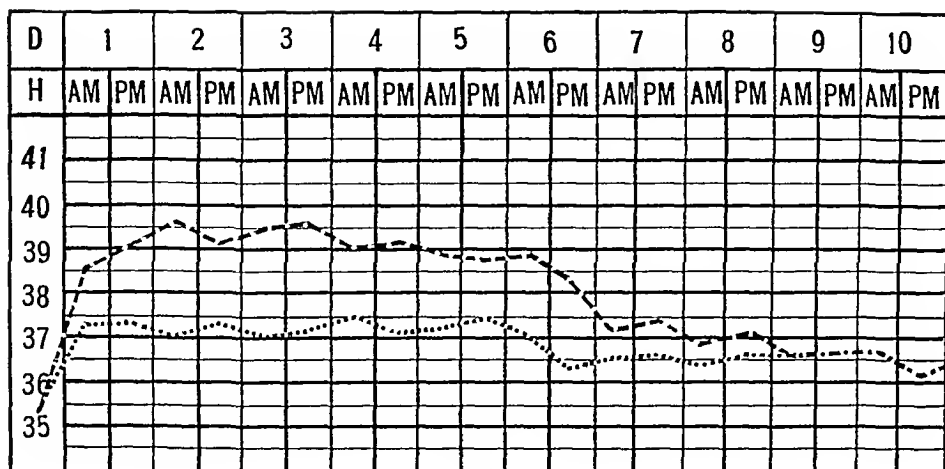
It is interesting to compare the temperature, pulse, and respiration of five patients in whom spine fusion was done in a single operation with those in five patients in whom either autogenous or homologous preserved bone grafts were used for spine fusion (Fig. 9). In most of the patients in whom this method has been employed, blood transfusion has been unnecessary, and shock and dehydration have been easily controlled. There has been no mortality due to the operation itself.

RESULTS

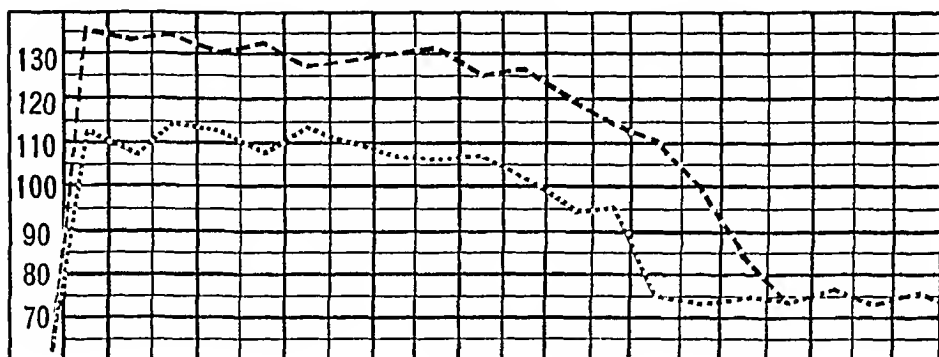
In fifty-two patients in whom preserved bone grafts have been used for different purposes, the final results have been checked in forty-three, or 82.7 per cent. of the total number. In thirty-two, or 74.4 per cent., of them, the end results were excellent or good, while in ten, or 23.3 per cent., they were poor or failures. The only death immediately after operation was due to uraemia, one month after fixation of a recent fracture of the neck of the femur.

It is very interesting to review the results obtained in the different conditions for which preserved bone was employed. For blocking purposes in paralytic drop-foot, the results have been good in every case. In ten cases of ununited fracture of the neck of the femur, bony union was obtained in nine. In two of these patients a complete regeneration of the

TEMPERATURE CHART



PULSE CHART



RESPIRATION CHART



FIG. 9

A comparative study of the postoperative temperature, pulse, and respiration rates. Dashed lines show the averages of five patients in whom spine fusions had been performed in a single operation, using fresh autogenous bone grafts.

Dotted lines indicate the averages of another five patients in whom spine fusions had been performed, using preserved autogenous or preserved homologous bone grafts.

Note the marked differences in the two groups.

neck which had absorbed has been produced by the bone graft. In connection with ununited fractures of the neck of the femur, it is of note that inveterate untreated syphilis has been a serious handicap and a cause of failure. The functional results in those patients in whom a bone graft was used in combination with a Smith-Petersen nail have been much better than in those in whom plaster was used for immobilization.

The end results in recent cases of fracture of the neck of the femur have been less satisfactory than those obtained in ununited fractures. Union has been obtained in 67 per cent. of the small series of patients operated upon. It must be emphasized that in five of the patients operated upon the graft-carrying nail has been used, and in only three patients have the massive graft and nail been employed.

It is very encouraging that no operative mortality has resulted from twenty-six spine fusions performed in two stages with preserved bone. In twenty of these patients the end results were checked a year or more after the operation. In sixteen, or 80 per cent., the graft has acted as any fresh bone graft would, and spine fusion has been obtained. The post-operative course in those cases has been extremely satisfactory.

Of forty-three patients in whom autogenous preserved bone has been used, final results have been checked in thirty-four. In twenty-four, or 70.6 per cent., of them the results were considered good. In two, the results were fair, and in eight, or 23.5 per cent., the operation failed.

In eight patients, homologous preserved bone was used. In six patients, or 75 per cent., the results were good; in one, the result was fair; and in one, a failure.

In the only case in which foetal bone was employed, fusion of the spine was obtained.

CONCLUSIONS

Autogenous or homologous preserved bone has been used for the treatment of several conditions in which bone-grafting was indicated, and has acted like any fresh bone in similar use.

In patients for whom the operative risk is great, or in patients from whom fresh autogenous bone is not obtainable, homologous preserved bone can be used successfully. In the fusion of numerous vertebrae, especially in small children, a two-stage operation, using preserved bone grafts, has greatly diminished the incidence of postoperative complications, and has eliminated mortality.

In ununited and fresh fractures of the neck of the femur, the preserved bone graft can be recommended, either alone or associated with a Smith-Petersen nail.

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VALGUS DEFORMITY OF THE KNEE RESULTING FROM INJURY TO THE LOWER FEMORAL EPIPHYSIS *†

BY LEROY C. ABBOTT, M.D., AND GERALD G. GILL, M.D.,
SAN FRANCISCO, CALIFORNIA

From the Department of Surgery, Division of Orthopaedic Surgery, University of California Medical School

In growing children injury to the epiphyseal cartilage plate of the lower end of the femur may cause a severe valgus deformity with functional shortening of the leg and an extreme degree of angulation. Its treatment constitutes a difficult problem for the orthopaedic surgeon. In this paper five cases of special interest are reported. One patient was seen at the time of the initial injury, so that it was possible to observe the development and progression of the deformity. Two were seen during the growth period with the deformity already well marked, and two were observed at the end of the period of growth when the deformed condition was fully developed.

As a result of these studies and this experience in the treatment of these patients the following points will be discussed:

1. The relationship of injury to the development of valgus deformity.
2. The pathogenesis of this deformity with special reference to the degree of angulation produced, the amount of total and functional shortening, and the development of secondary deformity in the tibia.
3. A method for the surgical correction of the deformity.
4. A plan of treatment when this condition is already present and increasing in the growing child.

THE RELATIONSHIP OF INJURY TO THE DEVELOPMENT OF VALGUS DEFORMITY

The femur and tibia are held together at the knee by ligamentous structures with no bony locking mechanism. For this reason, most injuries produce either pure epiphyseal separation in young children, or epiphyseal separation with associated diaphyseal fracture in older children. In a previous paper¹ it was pointed out that in such injuries, the line of separation passes between the calcifying cartilage cells of the epiphyseal plate and the metaphysis. Therefore, the epiphyseal cartilage and its

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blood supply are not necessarily damaged. Clinical experience verifies this fact, as deformity and disturbed growth are very rare, although epiphyseal separation at the knee is not infrequent. Disturbed growth results only from direct trauma to the epiphyseal cartilage plate or to the epiphysis. This type of injury is most uncommon, and in younger children follows crushing injuries, such as those which are due to a fall from a considerable height. In older children fractures of the epiphysis and the cartilage plate may occur in shearing injuries, but such cases are rare.

Several types of deformities have been reported, including absolute cessation of growth, genu flexum, genu recurvatum, genu varum, and genu valgum. The valgus type is the most frequent, because the lateral portion of the cartilage plate is most often crushed. This is due to the normal degree of valgus at the knee, and to the fact that the lateral side of the knee is more exposed to trauma. When injuries are due to a fall, the normal degree of valgus at the knee causes the greatest portion of the weight of the body to strike the lateral condyle; also in shearing injuries, the lateral portion of the plate is most frequently injured. Sometimes in these injuries to the epiphyseal plate, a fracture of the shaft of the femur on the same side also occurs. In the presence of this major injury, the damage to the epiphyseal plate may be overlooked, and its true significance may not be fully realized until deformity of the knee develops. The association of these two injuries is well demonstrated in two of these cases. In fractures of the shaft of the femur in children, especially those caused by falls, careful clinical and roentgenographic examinations should be made in order to rule out the possibility of injury to the epiphyseal plate of the lower end of the femur.

PATHOGENESIS OF THE VALGUS DEFORMITY

The crushing injury destroys the cartilage cells in the lateral portion of the epiphyseal cartilage plate. Healing occurs with the formation of scar tissue and a small bony lock between the epiphysis and the diaphysis. The undamaged mesial portion of the plate continues to grow downward and in a circular direction, with the bony lock as a pivot point, and gradually produces the valgus deformity. The degree of valgus is dependent on the exact location of the bony lock in the epiphyseal plate, and on the age of the patient at the time of injury. In older children who are near the period of cessation of growth, little or no deformity will take place. In young children severe deformity is certain to occur.

The longitudinal downgrowth of the medial condyle is never equal to the growth of the normal side, because the growing portion of the plate is gradually encroached upon by progressive union of the epiphysis to the diaphysis, proceeding from the lateral to the medial side. As a result of this process, the growing portion of the plate always fuses earlier than the corresponding epiphyseal cartilage plate of the normal femur. The actual growth is expended in a circular direction with the bony lock as a pivot point.

Because of these two facts, the amount of longitudinal downgrowth is also dependent upon the position of the bony lock. If the lock is at the exact lateral portion of the plate, the longitudinal downgrowth of the medial condyle is greater for a given growth increment, since the arc of the circle is larger. As more time is taken for the gradual encroachment of the medial side of the plate by the process of fusion, growth continues for a longer period of time. On the other hand, as the lock is removed from the lateral side, the medial side of the plate closes earlier, the arc of the circle is smaller, and the downgrowth of the medial condyle is lessened.

When the medial side of the plate fuses, the degree of deformity is fixed. Continued growth from the distal cartilage of the normal femur increases the relative inequality in length of the two legs.

In addition to the actual loss in length of the femur from the lack of longitudinal growth of the medial and lateral femoral condyles, there is decreased functional length from the degree of valgus of the knee. With increasing angulation the child finds it necessary to walk with the upper leg in more adduction in order to bear the weight upon the foot in both walking and standing. Therefore, the functional length of the leg is not represented by the actual lengths of the femur and tibia, but by a straight line from the femoral head to the medial malleolus. The functional loss of length becomes greater with the increasing degree of valgus according to the trigonometric formula for any triangle.* For this reason, the practical loss in length is always greater than that represented by the loss of growth of the lateral condyle, and much greater than the loss of growth of the medial condyle. This was well illustrated in two of the cases. In one patient with four inches of shortening of the medial condyle and five inches of shortening of the lateral condyle, there was a functional shortening of six inches. In another patient with even greater angulation, only one inch of shortening of the medial condyle was present and only three inches of shortening of the lateral condyle. However, there was six inches of functional shortening.

In children in whom the angulation is severe and has developed since early childhood, a compensatory deformity in the opposite direction is found in the tibia. This deformity or bending is in the region of the epiphyseal cartilage plate of the tibia. In two such cases no evidence of loss of growth or of compensatory overgrowth was found. This deformity is not due to disturbed growth, but to a bending of the bone in a varus direction, due to the faulty weight-bearing stresses produced by the valgus deformity of the femur.

The development of the femoral articular surfaces is not intrinsically disturbed by this deformity. It is the plane of motion in relation to the shaft of the femur which is altered. For this reason the range of motion

* ($a^2 = b^2 + c^2 - 2bc \cos A$), where a equals the functional length, A the degree of angulation, b the length of the femur from the head to the medial condyle, and c the length of the tibia from the medial condyle to the medial malleolus.

at the knee is normal. The muscle pull, however, exerted across the angulation is abnormal, and tends to displace the patella laterally. In one patient with severe angulation, the patella was displaced from the trochlear notch laterally into the angle formed by the femur and the tibia. All the soft structures on the lateral side of the thigh were relatively short in relation to the structures on the medial side. The peroneal nerve was likewise relatively short. These facts must be borne in mind in the consideration of operative correction. Laxity of the external lateral ligament has been observed in all of the cases of severe deformity. It is felt to be due to an attempt on the part of the patient to adduct the lower leg upon the femur in order to bear weight upon the foot while walking.

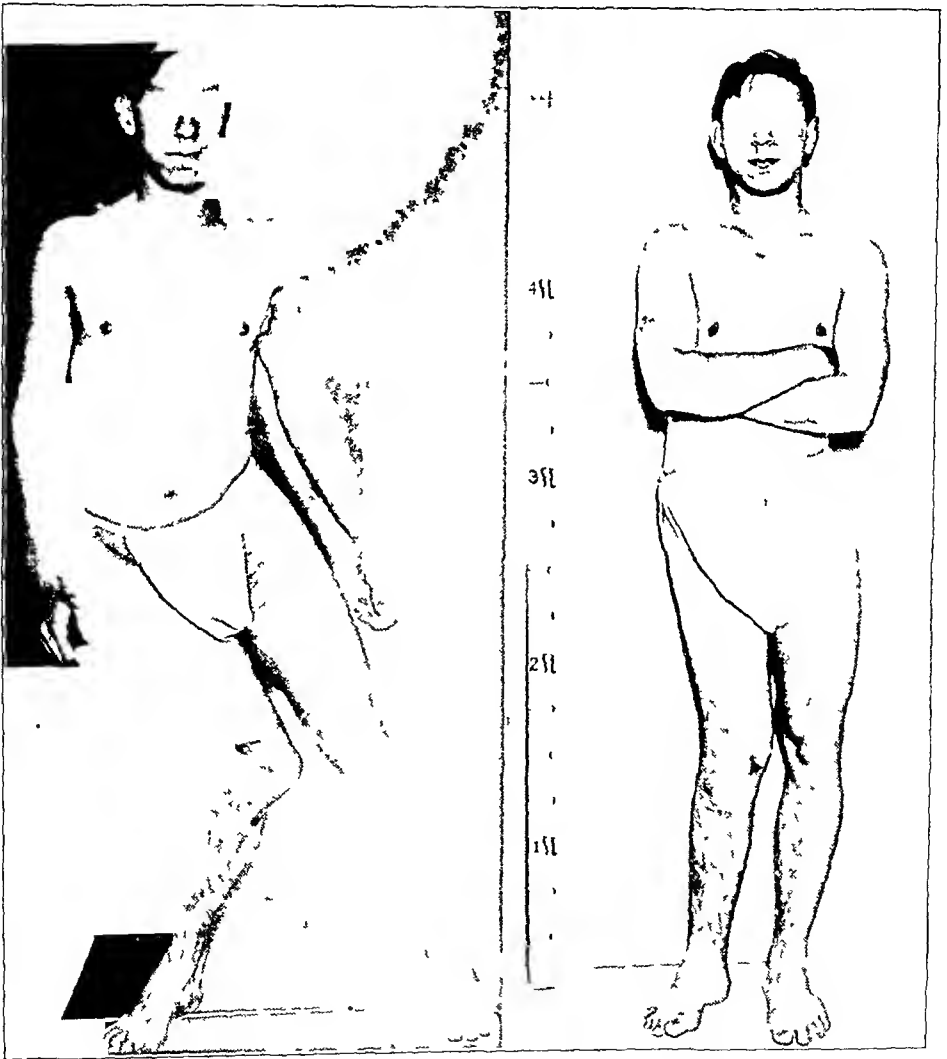


FIG 1-A

FIG 1-B

Fig 1-A. Case 1, A. I Photograph showing the deformity before operation. Note the markedly adducted position of the thigh with the functional shortening.

Fig 1-B. Photograph showing the correction obtained by excision of the medial condyle. The functional result was poor, because of limitation of motion at the knee.

THE SURGICAL TREATMENT OF VALGUS DEFORMITY

The purpose of surgical treatment of the far-advanced deformity is to secure complete correction with as much increase in the length of the leg as possible. The normal function of the knee should be maintained. Any residual inequality in the final length of the legs may subsequently be eliminated by leg-shortening or leg-lengthening operations.

In one patient a hemiarthroplasty was performed with excision of the medial condyle of the femur. The cosmetic result was good, but the functional outcome was very poor, because the motion of the knee was markedly restricted.

CASE 1. A. I., sixteen years of age, entered the hospital on June 17, 1935, for the correction of a severe valgus deformity of the right knee.

At the age of eight years, he was struck by an automobile and received a laceration at the lateral side of the knee. Infection apparently developed, because drains were placed in the wound. No roentgenograms were taken. One year after the accident a knock-knee deformity developed, which gradually increased in severity. The boy's gait became awkward, and, to compensate for the knock-knee, he held his hip in marked adduction (Fig. 1-A).

Examination revealed an extreme prominence of the medial condyle of the right femur. The leg was held at an angle of 45 degrees on the thigh, and a functional shortening of six inches was present. Although the patella was displaced laterally from the trochlear notch and contractions of the quadriceps muscle tended to increase the valgus deformity, the motion of the knee was good.

Comparative measurements taken from teleoroentgenograms revealed a loss of growth of three inches from the tip of the greater trochanter to the lateral epicondyle.

Operation was performed in two stages. On June 28, 1935, the soft structures on the lateral aspect of the knee were lengthened. On August 7, 1935, a part of the internal condyle of the femur was removed to permit a more complete correction of the deformity. The denuded surface of the condyle was covered with fascia lata. A low-grade infection followed operation, and there was drainage from the wound. Weight-bearing was begun ten months after the second operation.

The functional result in this case was unsatisfactory, because of painful and restricted motion of the knee joint (Fig. 1-B).

The oldest surgical procedure for the correction of a valgus deformity of the knee is a transverse osteotomy about three to four inches above the condyles of the femur, after which the leg is bent inward. This had been done very early in one of the patients (Case 5). In modern times the chief recommendation of this operation is its simplicity. Only fair reparation is accomplished, and an outward bowing of the thigh is produced, which may persist for a considerable length of time. Functional length is gained, but not as much as by other types of osteotomies to be later described.

A low oblique osteotomy, just above the epicondyles, allows correction at the site of the deformity, but unlike the higher osteotomy does not cause another deformity in the opposite direction at a higher level. This procedure may be varied in two ways. A triangular section of bone with its base facing inward may be removed from the medial side of the femur. This constitutes the well-known cuneiform osteotomy. The osteotomy may be performed at the same level, but wedged and held open on its

lateral side with a triangular section of bone usually taken from the ilium; this procedure is termed the open-wedge osteotomy. Increased functional length is obtained with either type, but the open-wedge osteotomy, by bringing the lateral condyle down to the level of the medial condyle, provides the greater length. The most satisfactory results are obtained in those cases where the details of procedure are carefully outlined in advance. This necessitates consideration of the type of osteotomy, the quality of the bone graft, the lengthening of the soft structures, and the required bony fixation. The possibility of postoperative lengthening must be borne in mind, and preparation made for this eventuality. In every case, tracings should be made from teleoroentgenograms of both femora and tibiae. These will reveal the absolute shortening of the bones, the functional shortening of the entire limb, the degree of valgus deformity, and the presence of compensatory deformity in the tibia. The site and type of osteotomy necessary for correction may be decided upon from these diagrams. By this means, a very good estimate of the expected gain in length can be obtained. As mentioned earlier, it is felt that a low oblique osteotomy, passing through the site of the deformity, if wedged open on the lateral side, will bring the lateral condyle down to the level of the medial condyle and give added length to the femur. When compensatory deformity is present in the tibia, full correction of the femoral deformity, even though resulting in a bowing of the lower leg, is desirable, because correction of the tibial bow will give additional functional length. The tibial osteotomy is similar in nature to the femoral one,—that is, a high oblique osteotomy wedged open on the medial side.

The surgical approach should be sufficiently long to give full exposure of the structures on the lateral aspect of the thigh and knee. The deep fascia may be incised in a long J-shaped incision, curving slightly below the patella. In the patients with marked lateral displacement of the patella, the quadriceps expansion may be similarly cut and freed from the lateral intermuscular septum. The biceps tendon is cut in a Z fashion, so that it may later be sutured in a lengthened position. The greatest obstacle to full correction is the peroneal nerve; to gain as much length as possible, this structure must be dissected free along its course in the lower thigh and especially from the bicipital fascia which binds it down upon the neck of the fibula. The lateral intermuscular septum should be cut from the lateral epicondyle, and stripped up as high as the site of the osteotomy. The lateral head of the gastrocnemius is freed from the posterior aspect of the lateral epicondyle.

The site of osteotomy is exposed by forward retraction of the vastus lateralis. The periosteum is elevated and the soft structures protected with Bennett retractors. The osteotomy is best performed with the Mayo saw, particular attention being paid to sectioning of the bone at the predetermined site. To allow for postoperative fixation of the fragments, the bone is cut a little higher across the lateral epicondyle, thus producing a small ledge on the lateral aspect of the distal fragment after it is rotated

around and downward. The osteotomy is then wedged open as far as possible without too much stretching of the peroneal nerve. Moderate relaxation of this structure may be gained by slight flexion of the knee.

A triangular graft of full thickness of iliac bone is used to fill in the opening wedge. Chip grafts have not been found satisfactory, because they are prone to become displaced into the medullary cavity and therefore give no stability. On the other hand the full-thickness graft, being bounded by a thin layer of cortical bone on three sides, has the necessary rigidity, and thus gives some fixation to the bones. It has been found to be rapidly and readily reorganized, probably because its center is composed of cancellous bone. The size of the graft may be predetermined from the tracings previously made. It is easily cut to the required size and shape. In some instances, where complete correction cannot be obtained at the time of operation, grafts may be smaller than originally planned.

If correction can be easily obtained, a long screw is passed from the ledge of the distal fragment across the osteotomy, transfixing the graft into the medial cortex of the proximal femoral fragment. If full correction cannot be obtained at the time of operation, a screw pin may be passed across the os-

teotomy and graft with its end protruding through the skin. In such cases, two additional, but heavier, screw pins are used. One is placed obliquely downward and medially through the proximal fragment of the femur, and one obliquely upward and medially through the upper tibia (Fig. 2-F). All three pins are caught and held in a specially devised clamp. The clamps are incorporated in the spica cast. About five weeks after the operation a turnbuckle is applied on the lateral side of the cast and a hinge on the medial side. The cast is then

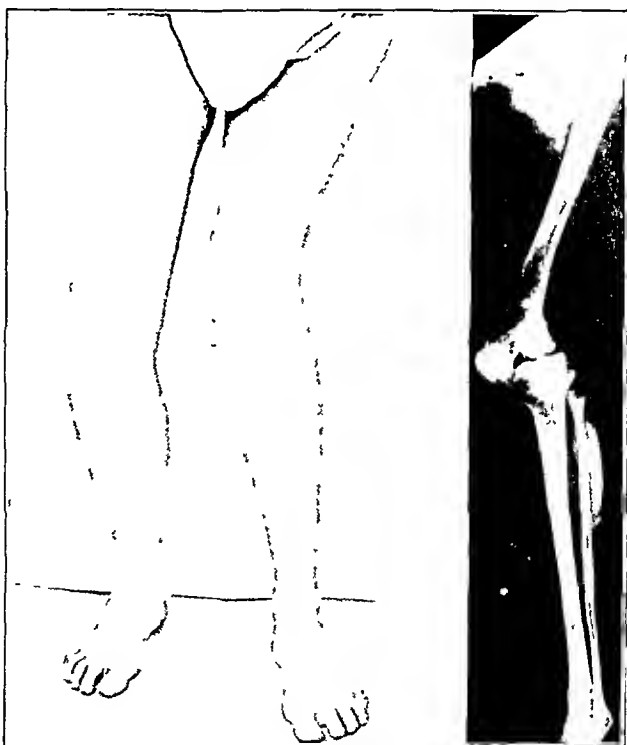


FIG. 2-A

FIG. 2-B

Fig. 2-A: Case 2. H. V. Photograph showing the severe valgus deformity.

Fig. 2-B: Teleoroentgenogram of the bone deformity. Six inches of functional shortening was present.

cut at the level of the site of the osteotomy. The transfixing screw pin is backed out until it disengages the proximal femoral fragment, and wedging is begun and continued slowly until full correction has been obtained, or until symptoms of stretching of the peroneal nerve ensue (Fig. 2-G). The screw will thus hold the graft to the distal fragment, which position is held until union is complete. Following removal of the apparatus, exercises for the knee are started. If compensatory deformity of the tibia is present, it should be corrected by a second osteotomy after the fragments at the site of the femoral osteotomy are firmly united. The oblique tibial osteotomy is performed similarly, and a small triangular graft of iliac bone is inserted into the open wedge on the medial side, and held with a transfixion screw or removable screw pin. Further fixation is obtained by means of a plaster cast (Fig. 2-H).

The following case report will illustrate the application of these principles in the treat-

ment of a case with severe and fully developed valgus deformity.

CASE 2. H.V., twenty-four years of age, sustained an injury to the left leg at the age of six years. It was stated that roentgenograms had revealed a small chip fracture at the lower end of the femur. Treatment consisted of a plaster-of-Paris cast which was worn for only a few weeks. Several months later the left leg began to turn outward at the knee, without pain. A corrective brace was prescribed, but the angulation continued to increase until the age of twelve years. From that time the deformity remained stationary. However, as the patient grew taller, the relative shortening of the left leg increased; this leg tired more easily on exertion than the right. On several occasions overexertion caused swelling and pain on motion, which lasted for several days.

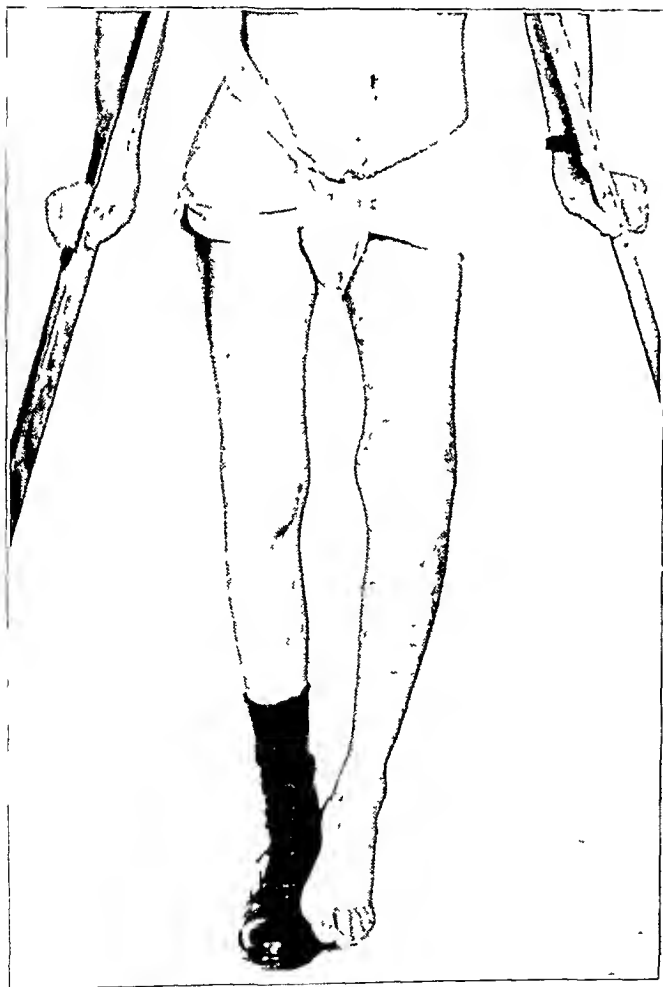


FIG. 2-C

Photograph after the supracondylar osteotomy. The full correction of the valgus deformity of the femur has produced a bowing of the leg. This is due to the compensatory varus deformity of the upper tibia.

Examination showed marked adduction of the upper leg when the patient tried to place the foot on the ground in walking (Fig. 2-A). Roentgenograms revealed a marked valgus deformity of the left knee caused by a lack of downgrowth of the lateral condyle of the femur (Fig. 2-B). The angle of the condyles with the shaft was about 40 degrees. Drawings were made from teleoroentgenograms. Comparative measurements from the tip of the greater trochanter to the lateral epicondyle revealed a shortening of five and two-tenths inches. Comparative measurements from the head of the femur to the medial condyle disclosed a loss of growth of four inches. Tracings of teleoroentgenograms of both legs, measured across the angulation from the head of the femur to the medial malleolus of the tibia, showed a total functional shortening of six inches in the left leg. The tibiae were the same length, although a compensatory varus deformity was present in the upper left tibia. A supracondylar open-wedge osteotomy of the femur was planned from the drawings as a primary operation, this

procedure to be followed by a high open-wedge osteotomy of the tibia. From the tracings it was believed that the complete final shortening could be reduced from six to three and three-quarters inches by these two procedures (Fig. 3).

The supracondylar osteotomy with iliac graft was performed on September 20, 1939. Full correction could not be obtained at this time, because the peroneal nerve would not permit it. The clamp and screw pins were applied, and the patient was placed in a spica cast (Fig. 2-F). On November 6, six weeks after the operation, the transfixing pin was backed out of the proximal fragment, the cast was split, hinges were applied, and wedging was begun by means of a turnbuckle. Correction was increased until December 4, when symptoms of stretching of the peroneal nerve manifested themselves (Fig. 2-G). One month later, January 5, 1940, the cast was removed and bony union was found to be complete (Fig. 2-C). Motion at the knee was begun and 40 degrees of flexion was obtained.

On May 1, 1940, the patient reentered the hospital, at which time an osteotomy of the tibia was performed. The line of osteotomy was oblique and ran upward from the medial to the lateral side to about one inch below the tibial tubercle. The osteotomy was planned so that the axis of rotation would pass through the proximal tibiofibular articulation. The iliac graft was placed in the open wedge on the medial side, and the corrected position was maintained by an oblique screw pin. Fixation was secured by means of a plaster-of-Paris cast, which was removed in August 1940 (Fig. 2-H).

The patient was last seen on April 24, 1941. The knee could be flexed to 90 degrees, and fully extended with good power. There was very slight lateral instability of the

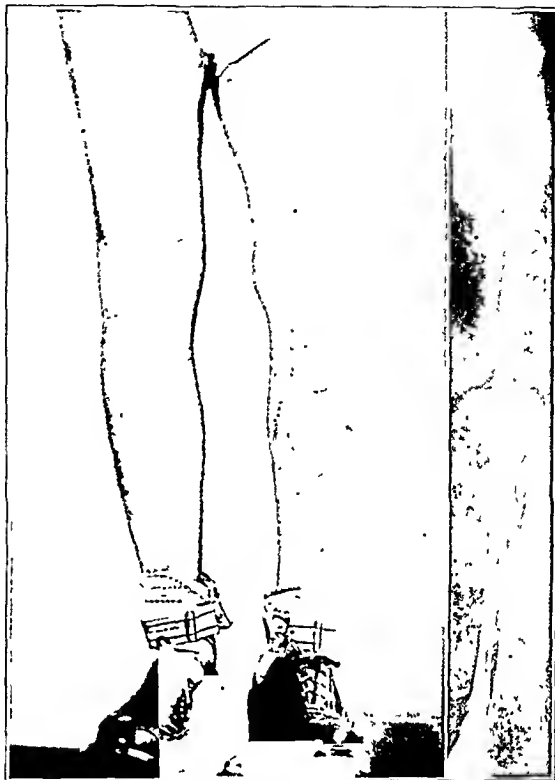


FIG. 2-D

FIG. 2-E

Case 2. H. V. Photograph and roentgenogram showing the final result. The patient has 100 degrees of flexion at the knee with good extension. Two inches in length has been gained.

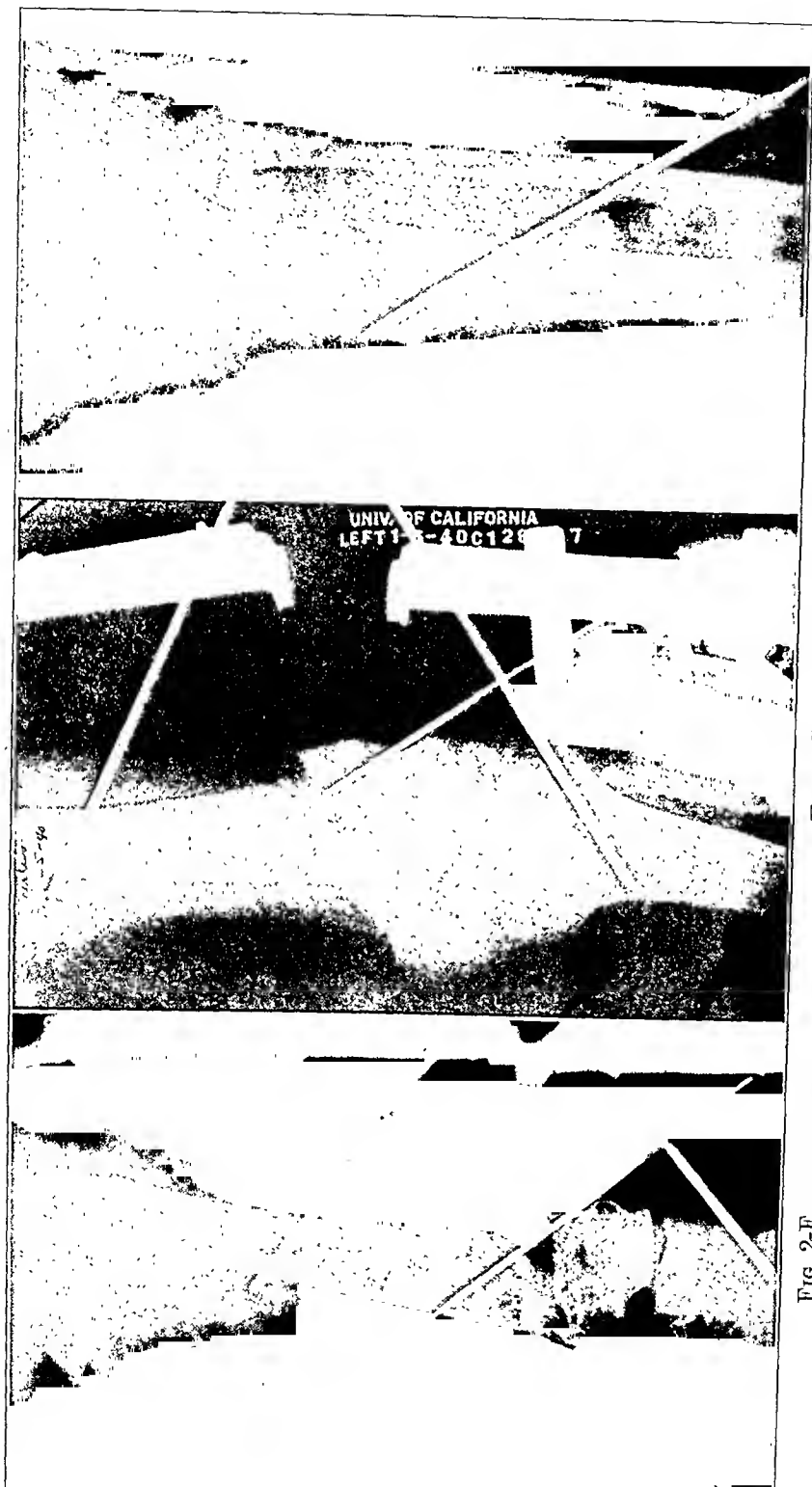


Fig. 2-H

Fig. 2-G

Fig. 2-F

CASE 2. H. V. Roentgenograms showing details of the corrective procedure.
 Fig. 2-F: Immediately after supracondylar osteotomy and insertion of the iliac graft.
 Fig. 2-G: After partial withdrawal of the transfixion pin and after wedging.
 Fig. 2-H: After osteotomy of the tibia, and insertion of the iliac graft and transfixion screw pin.

PLAN FOR OPERATIVE CORRECTION OF FULLY DEVELOPED GENU VALGUM
DEFORMITY AND END RESULT ATTAINED.

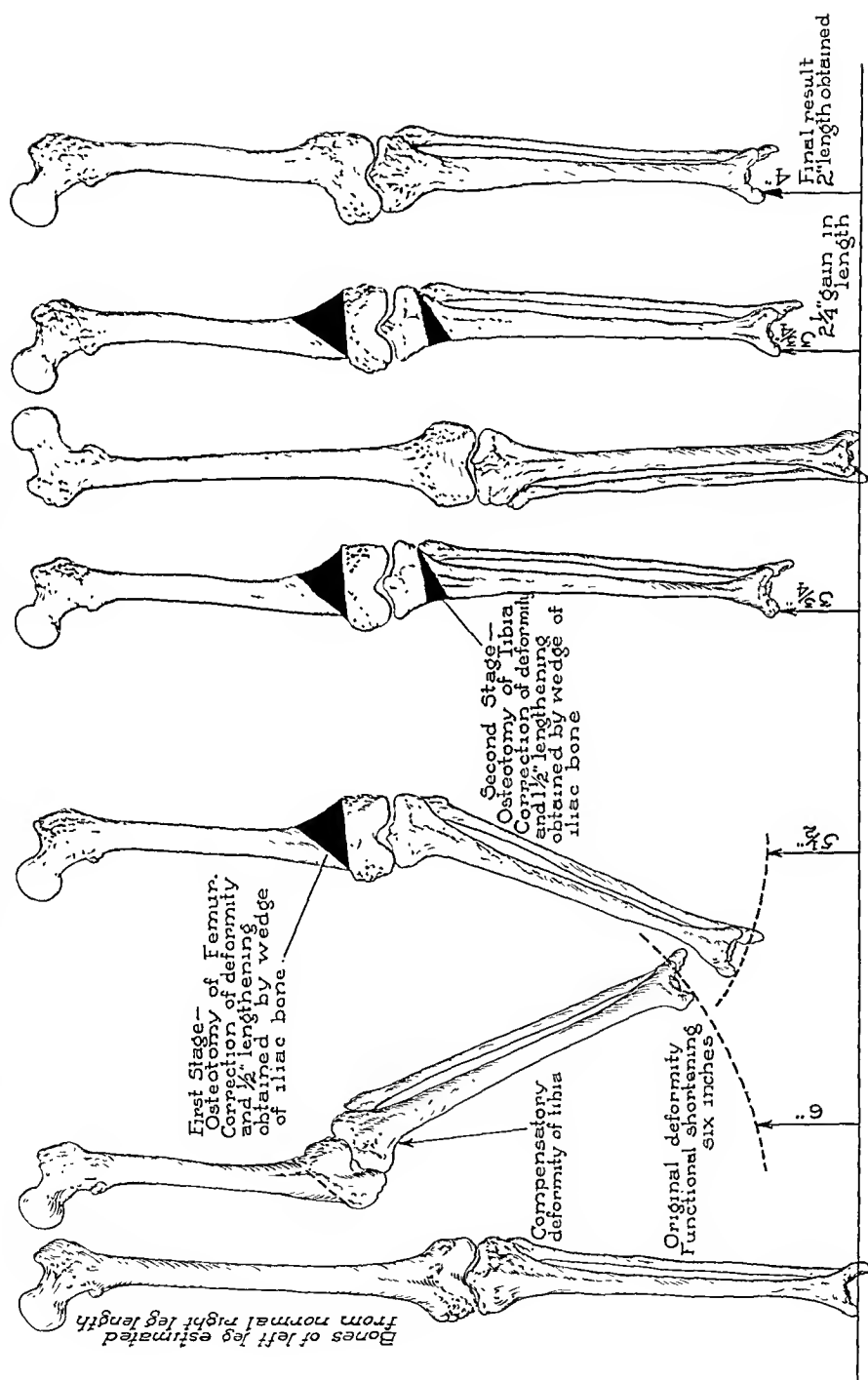


FIG. 3

Drawings from teleroentgenograms to show the plan of operative correction followed in Case 2 and the comparison of the final result with the preconceived plan.

knee, which caused no disability. The cosmetic result was good (Fig. 2-D). Teleoroentgenograms revealed very close correlation between the plan of operation (Fig. 3) and the correction actually secured (Fig. 2-E).

By means of two such osteotomies, as much as two inches of functional length may be gained. If an undesirable discrepancy is present after these procedures, the normal femur may be shortened or the involved femur may be lengthened. If it is obvious from the preoperative planning that shortening of the normal femur is desirable, time may be saved by performing this operation during the interval between the two osteotomies.

THE CORRECTION OF DEFORMITY IN THE GROWING CHILD

When a valgus deformity due to injury is developing in a growing child, continued growth from the medial portion of the affected cartilage plate and growth from the corresponding plate of the normal femur should be considered when surgical treatment is planned. It is the authors' opinion that the medial portion of the cartilage plate should be permitted to grow, and that the open-wedge osteotomy should be performed during the period of growth. Recurrence of the deformity will, of course, take place, and on first thought it would seem logical to delay surgical correction until the end of the growing period. However, if correction is delayed, the deformity is likely to become so severe and the relative shortness of the soft structures of the lateral aspect of the knee so marked that full correction of the deformity by the open-wedge method is much more difficult. For this reason, if possible, the medial condyle should never be permitted to overgrow the lateral condyle by more than three-quarters of an inch. In this way the shortening of the soft parts and nerves will never be great enough to require strenuous and prolonged postoperative lengthening. Therefore, as often as necessary during the period of growth the lateral condyle should be brought down to the level of the medial condyle, and in some instances, when further growth is anticipated, correction of the deformity may be obtained and the growth of the medial portion of the plate may be utilized to gain increased length. The deformity may recur and the osteotomy may be performed again or even a third time, the final correction being made at the time growth ceases in the medial portion of the plate. By these successive osteotomies from one to two inches of lateral femoral length may be obtained, and the functional shortening thus eliminated. Compensatory deformity of the tibia and strain on the ligaments of the knee will not ensue, because deformity and subsequent abnormal weight-bearing stresses are not allowed to develop to a marked degree. The patient is thereby enabled to enjoy the normal activities of childhood and early adult life, interrupted only by two comparatively short periods.

Fusion of the growing portion of the epiphyseal cartilage plate will also prevent the deformity from progressing, and, if performed at the inception of the difficulty, it will prevent deformity. It is believed that

this procedure is justified only if the growth potentiality is very small, or if the patient promises to be a fairly tall individual who can afford to sacrifice some longitudinal growth.

While the involved leg is being considered, the potential growth of the normal leg must be closely watched. The growth of the normal femur from its head to the medial condyle should never be permitted to exceed the length of the affected femur by more than two inches. If, at the time treatment is begun, the probable final stature of the child minus the expected growth from the injured center will give a satisfactory height, fusion of the epiphyseal cartilage plate of the normal femur should be done. As a result, the final discrepancy in leg length would be slightly over one inch, which may be compensated by a lift on the shoe.

The following case report illustrates the above principles of treatment.

CASE 3. R. J. was first examined at the age of five years and nine months. He had fallen from a three-story building and sustained a fractured skull, a compound comminuted fracture of the middle of the shaft of the left femur, and a small crushing fracture, involving the lateral portion of the epiphyseal cartilage plate and the lateral condyle, with no displacement. He was treated with traction, and an excellent correction of the fracture was obtained. He began to walk shortly thereafter and neither deformity nor shortening was present. Six months later an outward bowing of the left knee developed, and this gradually increased. The deformity was allowed to progress until the medial condyle had grown downward to about one inch below the lateral condyle. At this time the patient was eight years and four months of age. Growth-arrest lines in the normal femur demonstrated that a growth of one and one-half inches had occurred from the distal end. Comparative teleoroentgenograms from the tips of the trochanters to the lateral epicondyles showed one and one-half inches of shortening on the left side. This was equivalent to the growth which should have occurred normally. At this time, a low oblique supracondylar osteotomy of the femur was performed about one inch above the lateral epicondyle. The opening wedge was packed with iliac bone. The iliotibial band and the biceps muscle were lengthened, and the peroneal nerve was freed. The leg was placed in a spica cast. Wedging was begun immediately and continued for several weeks until overcorrection had been obtained. The postoperative course was uneventful, and, in about three and one-half months, he began to walk with the support of a brace.

When the patient was ten years old the deformity began to recur. Ten months later the medial condyle had overgrown the lateral condyle by one-half inch. At this time a supracondylar osteotomy was again suggested, but was rejected by the parents. Therefore, the medial portion of the epiphyseal cartilage plate at the lower end of the left femur and the entire distal epiphysis of the normal side were fused. Comparative teleoroentgenograms at this time revealed that, from the head of the femur to the tip of the medial condyle, the normal femur had exceeded in growth the involved femur by one and one-half inches. Growth-arrest lines showed that the normal femur had grown one and four-tenths inches from the distal epiphyseal cartilage between the ages of eight years and four months and ten years and ten months, and that the total growth of this center from the date of the original injury was two and nine-tenths inches. The downgrowth of the medial condyle of the affected femur was about one-half that of the normal femur. The comparative measurements from the tip of the trochanter to the lateral epicondyle were interesting, because they showed that the involved femur was two and two-tenths inches shorter than the normal one. From this it is seen that the oblique open-wedge osteotomy contributed seven-tenths of an inch to the length of the lateral side of the femur. If the osteotomy had been performed again, another one-half inch in length would no doubt have been gained. At the present time the patient

has a functional shortening of one and one-half inches. The fusion of the normal epiphyseal plate was done at the early age of ten years and ten months, because the predicted final stature of this individual was six feet and two inches, and the calculated growth from this center was three and one-half inches. Therefore, the loss of growth from fusion of the normal epiphysis would give a reduction in final stature to five feet and ten and one-half inches.

The child was last seen at the age of twelve years and nine months, at which time the inequality in the length of the legs had remained constant. The deformity at the

DEVELOPMENT OF DEFORMITY AFTER CRUSHING INJURY TO EPIPHYSEAL CARTILAGE PLATE AND RESULT AFTER OSTEOTOMY AND FINAL EPIPHYSEAL FUSION.

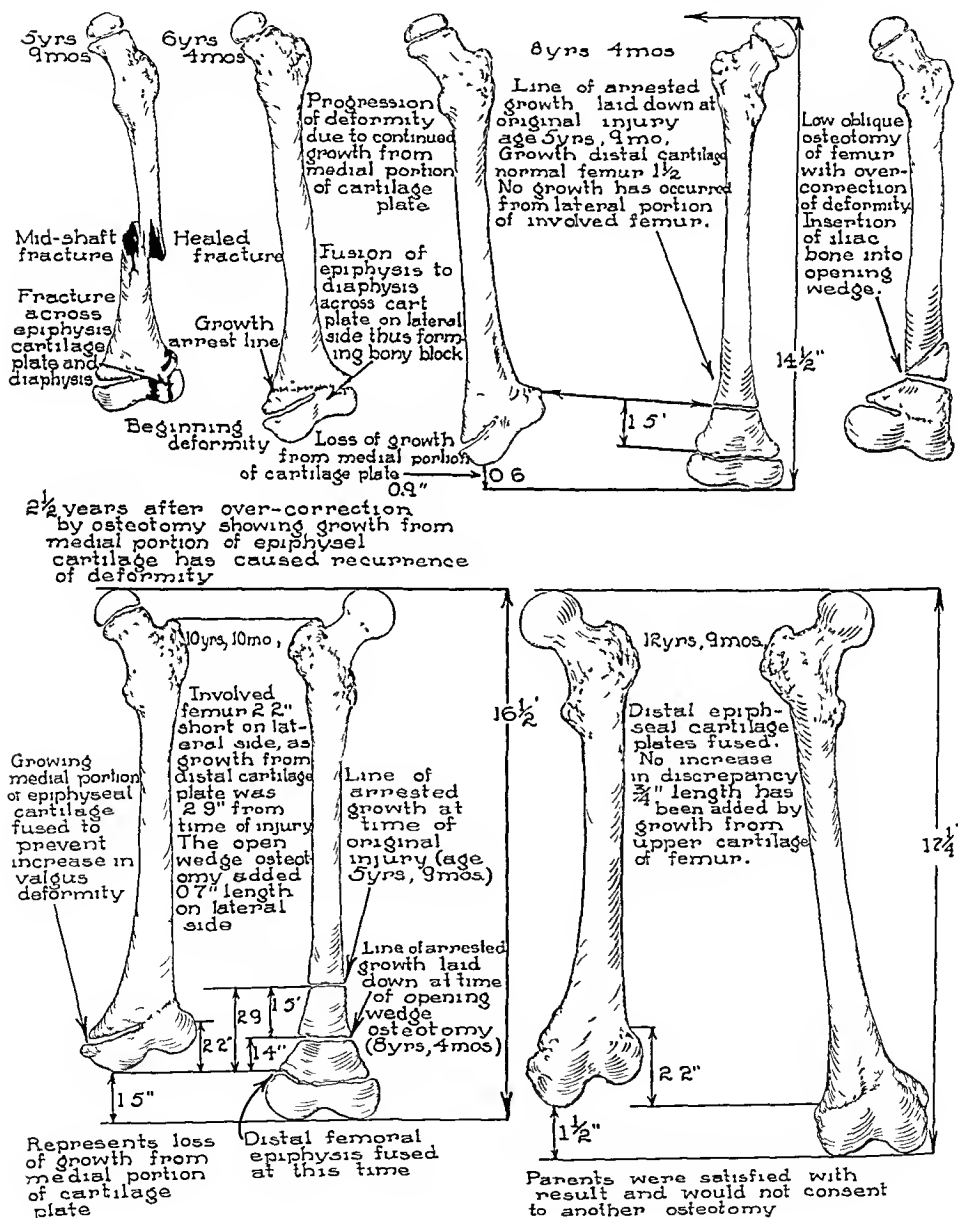


FIG. 4

Case 3. R. J. Drawings from roentgenograms to show the initial injury, the developing deformity, the operative correction, and the end result.

knee had not progressed and was hardly noticeable. Function was normal and there was only a slight degree of laxity of the external lateral ligament. When the patient stood on the good leg, his height was already five feet and five inches (Fig. 4).

A somewhat comparable case was treated in a very different manner.

CASE 4. L. H., at the age of twelve, sustained a fracture of the shaft of the right femur in an automobile accident. Two deep cuts on his right knee were apparently disregarded. A cast was applied and he was discharged after a month's time. However, he returned to the hospital because of displacement of the bone fragments. Four months later weight-bearing was begun. After he had been walking for two months, an increasing valgus deformity of the right knee was noted. At the time of entering the hospital at the age of thirteen years and ten months, a marked valgus deformity was present with almost one inch of shortening on the lateral side of the femur. A closed-wedge osteotomy was performed, and the medial growing side of the plate was fused. The fragments were held by means of a metal staple. Four months later there was solid union and the patient began to walk. The deformity remained stationary and did not recur. The patient was able to carry on a very active life.

He was seen again at the age of seventeen years and eight months, following an injury sustained while pole-vaulting. At this time he had slight lateral mobility. Immobilization in a plaster-of-Paris cast for five weeks relieved the pain; the knee was stable; and a normal range of motion was present. Externally the knee appeared to have a slight posterior angulation of the femoral condyles and a slight anterior angulation of the upper tibia.

Teleoroentgenographic measurements from the trochanters to the lateral epicondyles revealed a comparative shortening of two and six-tenths inches. As the closed-wedge osteotomy did not disturb the length on the lateral side of the femur, this difference must represent the actual growth of the distal epiphyseal cartilage of the normal femur from the time of injury. Measurements from the heads of the femora to the medial condyles revealed a shortening of two and two-tenths inches. These figures demonstrated that the loss of length of the medial side of the femur was not so great as that on the lateral side, even though some length was sacrificed by the closed-wedge osteotomy. This shortening could have been reduced to less than one inch, if fusion of the distal epiphyseal cartilage of the normal femur had been done at that time. However, as the final height is only sixty-eight inches, this procedure would have reduced it to about sixty-six and five-tenths inches, which is on the short side.

The authors believe that open-wedge osteotomies would have been preferable in this case. At the time of the operation, the medial condyle had overgrown the lateral condyle by about eight-tenths of an inch, and this length was sacrificed by the closed-wedge osteotomy. In addition, if the medial growing portion of the plate had not been fused, it would have grown another inch, as the growth from the distal epiphyseal cartilage plate of the normal femur was about one and seven-tenths inches. Had open-wedge osteotomies been done, from one and one-half to two inches of length would have been gained, and this would have left a shortening of less than one inch instead of the present shortening of over two and one-half inches.

It is felt that the closed-wedge osteotomy, with attendant fusion of the growing portion of the cartilage plate and of the corresponding cartilage plate of the normal femur, should be done only if very little growth expectation remains, or if the expected final stature is predicted to be such that the loss of growth by this procedure will not be too great.

In patients with inception of the deformity from very early childhood, and in whom the open-wedge osteotomy combined with fusion of the epiphyseal cartilage plate of the normal femur would result in too great a decrease in total final stature, a plan for the lengthening of the involved femur should be made. Difficulties will be encountered, however, if the lengthening is not done until after the valgus deformity has been corrected as shown in the following case report.

CASE 5. J. B. When the patient was two years old, the parents noted the development of an outward angulation at the right knee. No definite history of trauma was obtainable, but roentgenograms taken at that time revealed a fusion of the lateral portion of the epiphysis to the diaphysis. At the age of five years a supracondylar osteotomy was performed at a point more than two inches above the condyles, and the leg was bent inward. This gave fair correction of the deformity, which, however, soon recurred. At the age of nine years the deformity had become stationary, but the discrepancy in length had increased. The girl entered the hospital at the age of twelve years. A marked valgus deformity was present, as well as a shortening of the entire leg of over four inches. A femoral lengthening was performed. Lengthening of two inches was obtained, and the valgus deformity was apparently lessened. This decrease in the valgus deformity was produced by a lateral bowing at the site of the lengthening, which converted the femur into an S-shaped curve.

Fusion of the distal epiphyseal cartilage plate of the normal femur was performed at the age of twelve years and nine months. Nine months later she entered the hospital for correction of the remaining valgus deformity of the right knee. There was a question as to whether the procedure should not be divided with correction of the bowing of the mid-femur before the supracondylar osteotomy was performed. It was wished not to submit this patient to two operations, and, since it was thought that the bowing would tend to decrease, the supracondylar osteotomy was decided upon. This was performed at the age of thirteen years and four months. The wedge was packed with chips of iliac bone. These gave no stability and became displaced into the medullary cavity. The osteotomy was held by a transfixing screw pin and two other pins,—one in the femur and one in the tibia. These two pins were caught in a clamp. In four months' time the fragments were solid and motion was begun at the knee. The patient was last seen on May 15, 1941. When she stood on the normal leg, her height was sixty-two inches. A lift of two and one-half inches was required to balance the pelvis. A marked bowing of the mid-femur was present, although the general alignment of the lower leg with the body was good. The plane of motion at the knee joint was normal, and the range of motion was from 180 to 90 degrees. The power of extension of the knee was poor, due in part to the abnormal muscle pull across the bow of the femur.

The correction of the lateral bow of the femur by osteotomy is now being considered. This will probably necessitate a further correction of the valgus deformity of the knee.

SUMMARY AND CONCLUSIONS

1. Valgus deformity of the knee, following injury in childhood, is commonly the result of premature closure of the lateral portion of the epiphyseal cartilage plate of the distal end of the femur. The type of injury producing this premature closure is a crushing of the cartilage plate, and is most commonly received from a fall from a considerable height.

2. Severe angulation of the knee occurs if the injury takes place in a young child. Marked loss of function is caused by the degree of angulation and shortening.

3. Supracondylar osteotomy of the open-wedge type, with lengthening of the soft structures on the lateral side of the knee, gives excellent anatomical reconstruction and added length to the femur.

4. If compensatory deformity of the tibia is present, this should also be corrected by open-wedge osteotomy, which gives additional length to the leg.

5. The osteotomies should be carefully outlined on tracings of the teleoroentgenograms.

6. A triangular, full-thickness wedge of iliac bone has been found to be the most advantageous type of bone graft to place in the open wedge.

7. In the growing child with developing deformity, open-wedge osteotomy should be performed before the medial condyle has overgrown the lateral condyle by more than one inch. The operation should be repeated as often as necessary during the period of growth. In this manner, added length is obtained with each osteotomy; the deformity is never severe; and correction is easier to obtain.

8. Arrest of the corresponding epiphyseal cartilage plate of the normal femur should be performed before the normal femur has overgrown the involved femur by more than two inches, providing the expected final height is satisfactory with this loss of growth.

9. If necessary to give a more desirable final height, femoral lengthening may be performed. It should not be done until the valgus deformity has been fully corrected.

1. GILL, G. G., AND ABBOTT, L. C.: Varus Deformity of Ankle Following Injury to Distal Epiphyseal Cartilage of Tibia in Growing Children. Surg. Gynec. Obstet., LXXII, 659, 1941.

CALCAREOUS TENDINITIS IN THE METACARPO-PHALANGEAL REGION *

BY WILLIAM COOPER, M.D., NEW YORK, N. Y.

From the Hospital for the Ruptured and Crippled, New York

Amorphous calcium deposits in the soft tissues about joints has in recent years become a very familiar phenomenon, and has been variously reported as *bursitis calculosa*, *calcifying bursitis*, *tendinitis calcificans*, *peritendinitis calcarea*, but most frequently as simply *bursitis with a deposit*. It has been demonstrated in many body areas, most familiarly in the subdeltoid, trochanteric, and radiohumeral locations. This paper will discuss another type, less familiar perhaps, but possessing characteristics common to the phenomenon as a whole, and, because of its location, presenting interesting differential features.

Growing experience with the general condition of so-called calcareous bursitis, and a review of the reported material, seems to indicate rather convincingly that it is a genuine disease entity, having a typical pathology and symptomatology common to all areas involved.

Pathological studies have been reported of the various areas in which calcification occurs, and the findings have been quite consistent. Practically all seem to indicate that the condition is secondary to a degenerative change in the tendons, or the adjacent ligamentous or capsular structures. The most conspicuous histological feature is the degenerative

alteration in the fibrous tissue (Figs. 2-A and 2-B). The degeneration may vary in degree from trivial loss of microscopic detail in the connective tissue, to true necrosis. In such areas, apparently because of deficient blood supply, calcium is deposited in the form of calcium phosphate or of calcium carbonate, or a molecular combination of both. The blood vessels in

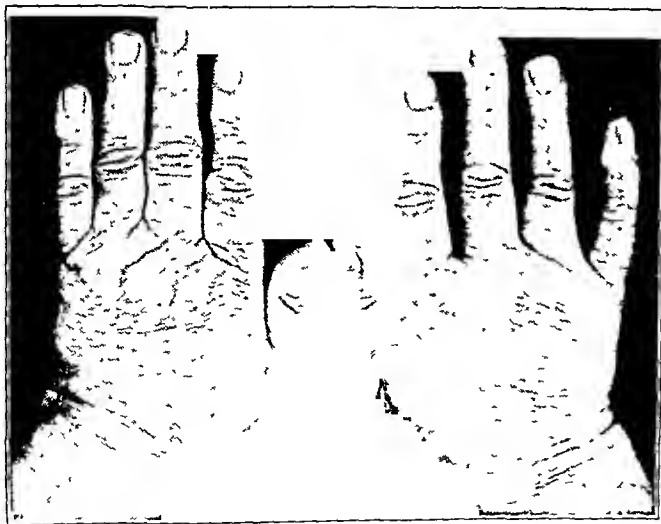


FIG. 1-A

Case 1. Photograph at the time of onset showing swelling of the affected hand.

* Presented at the Orthopaedic Section, New York Academy of Medicine, April 18, 1941.

bone marrow are given. A biopsy of the bone is extremely important in these unusual conditions of anaemia and leukaemia for it supplements the findings in the blood studies. The photomicrographs of the pathological sections of the bone marrow with the differential cell count are of diagnostic value to any who are working in this field.

The blood plates in color are always helpful to the hematologist. In this book there are more than forty, a few of which are new in this edition.

This work combines the clinical descriptions of blood diseases with a presentation of hematological methods, and is illustrated by many colored plates, thus making it a valuable handbook for the clinician as well as for the laboratory worker.

SYNOPSIS OF THE PREPARATION AND AFTERCARE OF SURGICAL PATIENTS. Hugh C. Ilgenfritz, A.B., M.D., and Rawley M. Penick, Jr., Ph.B., M.D., F.A.C.S; with Foreword by Urban Maes, M.D., D.Sc., F.A.C.S. St. Louis, The C. V. Mosby Co., 1941. \$5.00.

In the general surgical field, there has been little recent change in operative procedures. Details may vary from time to time, but the accepted technique for the majority of operations is fairly well standardized. However, advances in treatment of surgical conditions from a physiological standpoint have been rapid and numerous. It is becoming more evident that future progress and success in surgery will depend upon a close cooperation between the surgeon and the scientific investigator. Already certain physiological facts in relation to preoperative and postoperative care have become standardized.

This volume of 480 pages, with fifty-five illustrations, covers thoroughly certain standardized physiological considerations important in the care of the surgical patient before and following operation. In certain conditions, such as intestinal obstruction, in certain studies, such as the pathological physiology of the liver, the thyroid, and the blood dyscrasias, important recent advances have been made. Often constitutional diseases have to be corrected and cardiac or renal conditions properly treated, if the surgical operation is to be successful. The present status of prothrombin in relation to the patient with a jaundiced gall bladder, and the advent of the sulfonamides are examples of recent advances in the care of the surgical patient. Controversial points and descriptions of various technical procedures have been omitted.

The volume as a whole is concise and compact, being almost a pocket manual. The book will prove of value to any one concerned with the preparation and after care of surgical patients.

WOUNDS AND FRACTURES. A. CLINICAL GUIDE TO CIVIL AND MILITARY PRACTICE. H. Winnett Orr, M.D., F.A.C.S. Springfield, Illinois, Charles C. Thomas, 1941. \$5.00.

The book is nicely bound in a conveniently sized edition, and is excellently illustrated. The material is presented in a rather unusual manner, being somewhat didactic and testimonial in character,—in reality a textbook with illustrative cases. It lacks statistical evidence to confirm the author's claims. However, one can readily understand that it would be difficult to present adequately controlled statistics on the subject. The style of presentation is of the ex-cathedra type, and smacks of the publications of the later years of the nineteenth century.

The preface is long and a bit dull, but near the end the object of the book is more or less definitely stated; it is more definitely defined in the following paragraph quoted from the book:

"It is intended in this book to consider a series of fracture cases grouped by problems, as well as by regions; to describe certain successful technics, and to discuss fundamentals in treatment. In some instances failure to comply fully with sound principles necessitates secondary operations, such as refracture or repair. The attempt will be made to call attention to the reasons for success or failure of various 'methods'. It can be

The treatment consists of incision of abscesses and immobilization of the affected part. In every case healing occurred, but there was some stiffness of the back.—

Walter P. Blount, M.D., Milwaukee, Wisconsin.

ÜBER CALCANEUSFRAKTUREN (Fractures of the Calcaneum). Thore Olovson. *Acta Orthopaedica Scandinavica*, XI, 199, 1940.

A statistical review of 448 cases of fracture of the calcaneum from the files of the National Insurance Company of Stockholm, from 1924 to 1933, show that these fractures have been increasing in frequency in recent years. They represented 0.68 per cent. of the total fractures registered and 4.9 per cent. of all fractures of the bones of the foot. Forty and two-tenths per cent. were caused by falls from ladders; 23.5 per cent., by falls from scaffolds. The average height of the fall was three and four-tenths meters. In the falls from greater heights, both extremities were fractured, and the indemnity was larger. Additional fractures were found in 8.7 per cent. of the cases. Forty-three per cent. of the fractures were on the right and 55 per cent. were on the left.

Prior to 1929, the method of treatment was conservative without reposition of the fragments. After that year, active reduction according to the methods of Bohler and Westhues was used more. Some improvement in late end results was noted after the establishment of active treatment.—Walter P. Blount, M.D., Milwaukee, Wisconsin.

CONTRIBUTION TO THE KNOWLEDGE OF CONGENITAL DISLOCATION OF THE HIP JOINT.

LATE RESULTS OF CLOSED REDUCTION AND ARTHROGRAPHIC STUDIES OF RECENT CASES. Erik Severin. *Acta Chirurgica Scandinavica*, LXXXIV, Supplementum 63, 1941.

In one of the most thorough, and certainly the most critical, end-result studies of congenital dislocation of the hip to be produced, Severin offers a detailed study of the results, which were primarily successful, in 330 patients with 454 treated hips from 1913 to 1932. Only four patients were lost. All of the hips were treated by the method of Dr. Haglund and under his direction. Recexamination (not questionnaire study) five to twenty-seven years after treatment showed the following roentgenographic-anatomical condition.

	Per Cent.
"I Well developed hips roentgenologically . .	4 24
II Moderate deformation of the femoral head, neck, or acetabulum. but a well built joint otherwise	7 14
III Dysplasia, not subluxation	8 01
IV Subluxation	43 75
V The femoral head in a secondary acetabulum in the upper part of the original one	12 95
VI Re-dislocation	16 96
Dead	5 58
Not re-examined	1 31"

All of the groups except the first showed deformity of the femoral head and neck. Early treatment gave the best results, and the writer agrees that treatment should be begun as early as possible.

Fifty-seven of the "health" hips in the 190 unilateral cases showed a definite dysplasia or subluxation.

Functional results were better than the roentgenographic-anatomical ones, but good function was frequently reported in the cases with poor anatomical results. It was noted that function in such cases deteriorated as did the anatomical appearance of the joint with the passage of time.

Arthrographic studies were made on normal and on abnormal hips in children. It

THE FOOT AND ANKLE. THEIR INJURIES, DISEASES, DEFORMITIES AND DISABILITIES, WITH SPECIAL APPLICATION TO MILITARY PRACTICE. Ed. 2. Philip Lewin, M.D., F.A.C.S. Philadelphia, Lea & Febiger, 1941. \$9.00.

The second edition of this treatise on the foot covers the subject completely. The text is well arranged, and the style is lucid and concise. The illustrations, with a few exceptions, are well chosen and clear.

Beginning with a discussion of the anatomy and embryology of the foot, the various chapters explain clearly the different ills which befall the human foot and their treatment. The chapter on the examination of the foot is especially praiseworthy and may well serve as a guide to those who are called upon to treat these disabilities. While many orthopaedic surgeons will not agree entirely with all of the treatment advised, the basic principles laid down in the book are sound.

This book should be very helpful to every orthopaedic surgeon and should be a valuable reference book for the chiropodist.

DIAGNOSTIC ROENTGENOLOGY. [Renewal Pages.] Ross Golden, M.D., Editor. New York, Thomas Nelson and Sons, 1941.

In these days when changes and advances in all departments of medicine and surgery are occurring so rapidly that there is almost a new order, not only in treatment but in diagnosis, it is of advantage and of value to have a record of the recent contributions to attach to the record of the preceding period. The old in that way becomes a steppingstone to the new. This is a contribution which is made by Thomas Nelson and Sons in their Loose-Leaf method of publishing recent discoveries. Renewal pages for "Diagnostic Roentgenology", edited by Dr. Ross Golden, are so arranged that they may be substituted for, or added in the proper order to those which have previously appeared, and thereby preserve the continuity of the different chapters. With the 600 pages just issued, the second renewal service, the work on this subject has now become expanded into two volumes, and a binder for Volume II is included. In addition to the new material, there is a revised index, table of contents, and list of contributors.

The work has already earned its place in the field of medical literature, and now, in addition to the revision of the subjects already published, there are in this present series five new chapters by authors well known from their position in their special departments. These new chapters are on the following subjects: The Roentgen Diagnosis of Fractures and Dislocations, Roentgen Diagnosis in Infants and Children, Soft-Tissue Roentgenography, Laminagraphy, and Angiography. The revision of the chapter on Roentgen-Ray Diagnosis of Diseases of the Skull and Intracranial Contents comprises 230 pages with 336 illustrations, and there is an addendum to the chapter on Radiology of the Chest.

As in the first two of the series, the text is supplemented by many roentgenograms, excellently reproduced.

SEPTIC SPONDYLITIS. REPORT OF SEVEN CASES. Lars Holmberg. *Acta Chirurgica Scandinavica*, LXXXIV, 479, 1941.

A detailed review of seven cases of septic spondylitis furnishes an opportunity for a study of this subject. Five of the cases were caused by staphylococci, one by streptococci, and one perhaps by the influenza virus. Trauma was not considered of importance. In three cases there were double isolated lesions, two of them involving the laminae. Three patients were under twenty years of age and four were over. Six cases were acute with abscesses, and one was chronic without an abscess.

The roentgenogram is of assistance in the early diagnosis by showing the shadows of abscesses and oedema. Later in the disease, the roentgenographic appearance differs from that of the tuberculous spine. The writer suggests that the septic lesion usually starts in the "diaphyseal part". It usually has uneven edges with a regenerative reaction in the surrounding tissue.

The treatment consists of incision of abscesses and immobilization of the affected part. In every case healing occurred, but there was some stiffness of the back.—

Walter P. Blount, M.D., Milwaukee, Wisconsin.

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was found that when a fully dislocated hip was reduced after the age of one year, the limbus, immediately after reduction, did not embrace the femoral head to the normal extent, but gradually did so within the next few months, if the reduction was maintained. It was also discovered from arthrography that changes of the capital nucleus of the coxa plana type may be associated with deformity of the cartilaginous head, but may occur also with retention of the spherical shape of the head. Usually the shape and size of the femoral head became normal during the first year following reduction.

This monograph could certainly be read with profit by every orthopaedic surgeon who is called upon to give a prognosis in cases of congenital dislocation of the hip.—*Walter P. Blount, M.D., Milwaukee, Wisconsin.*

DIE FRONTALE WIRBELKÖRPERSPALTE (Frontal Fissure of the Vertebrae). Folke Knutsson. *Acta Radiologica*, XXI, 597, 1940.

In 1931 Loosen described a thirty-centimeter foetus, in which the vertebral bodies presented evidence of a frontal fissure. The present author has had occasion to observe three similar cases. In one case, death occurred from an oesophageal malformation. At autopsy, the appearance of the fissure was found to be due to the persistence of cartilage between an anterior bony nucleus and a posterior bony nucleus, which normally occurs in the body of the vertebra. In the other two cases, the fissure was found to involve not only the lumbar, but also the thoracic area of the spine. In these the fissure was found to have closed within two to four months, leaving a normal-appearing vertebral body.

In the opinion of the author, the frontal fissure is a normal stage in the bone development of the vertebral body. It is usually found within the first month of birth and normally disappears within two to three months. Of course, no treatment is indicated.—*Henry Milch, M.D., New York, N. Y.*

SOME CASES OF SOLDIER'S FRACTURE. Jens Munck Nordentoft. *Acta Radiologica*, XXI, 615, 1940.

"Soldier's fracture" has appeared in the literature under the designations of insufficiency fracture, osteopathia itineraria, stress injuries, and work periostitis. Typically, the metatarsal bones are the site of the injury. But the tibia, the fibula, the pelvis, the femoral neck, and the lower end of the femur have been affected. These fractures occur as the result of mechanical strain, consequent upon continued, rhythmic, and unaccustomed work.

Therapeutically, these cases present no difficulty. The main problem arises in the differential diagnosis between them and the early stages of Ewing's sarcoma. Both conditions present roentgenographic evidences of "onion-skin" periosteal reaction, with thickening of the cortex. In doubtful cases, biopsy alone can establish the diagnosis. Four illustrative cases are presented.—*Henry Milch, M.D., New York, N. Y.*

ON BIPARTITE OS NAVICULARE PEDIS. Erik de Fine Licht. *Acta Radiologica*, XXII, 377, 1941.

Clinically, these cases present no characteristic features. Pain on walking or standing may be marked or very mild. There may be some restriction of motion and "examination oftenest shows an osseous prominence in the tarsal region, just in front of the medial malleolus".

"The roentgenographic picture, on the other hand, is very characteristic. In dorso-plantar projection one finds on one, or often on both sides, of the navicular, a wedge-shaped alteration of the bone, with the base of the wedge directed medially, the point laterally. Besides, one finds, lateral to the point of this wedge, a vague, indefinite shadow . . . [which] represents a small, dorsally situated part of the bone. In the side view this

shadow . . . is as a rule triangular, and may be more or less distinctly separate from the rest of the navicular."

The condition is probably congenital in origin. It may arise as the result of ossification of two separate nuclei, or as the result of the wandering of a secondary cuboid bone. The condition usually causes no symptoms in young individuals, but predisposes to the early development of arthrosis. The treatment must be orthopaedic and may justify surgical intervention.—*Henry Milch, M.D., New York, N. Y.*

ANEURYSM OF AN INTERCOSTAL ARTERY WITH SIMULTANEOUS, SACROMATOUS DESTRUCTION OF AN ADJACENT, DORSAL VERTEBRA. Nils P. G. Edling. *Acta Radiologica*, XXII, 411, 1941.

Apart from a purely theoretical speculation as to the etiology of the two conditions, the paper is interesting for the details of the case.

A year before admission to the hospital, the patient began to complain of digestive trouble, an abdominal pain under the right costal arch, radiating up the back and into the right shoulder. On admission, an area of dullness was detected below the right scapula, close to the spinal column.

The roentgenogram revealed "a round, dense area, the size of an infant's head with sharp, evenly-rounded outlines, within the lower portion of the right pulmonary field adjoining the heart shadow". It was situated close to the spinal column, from which it could not be projected. "The center of the dense area was on a level with the ninth dorsal vertebra, which showed signs of destruction."

Aspiration of the mass, after costal resection, revealed a few cubic centimeters of blood. No tumor mass could be palpated through the pleura.

At autopsy, the vertebra was found to be the site of an osteogenic sarcoma. The rounded mass seen on the roentgenogram was considered to be an aneurysm of an intercostal artery. The mass extended from the seventh to the tenth thoracic vertebrae, and was largely extrapleural, but the communication with the involved intercostal artery could not be demonstrated.

The condition must be differentiated from an encapsulated exudate, primary osteogenic sarcoma, mediastinal lipomata, fibromata, or neurinomata, and metastatic neoplasia.—*Henry Milch, M.D., New York, N. Y.*

FRACTURES OF THE SPINE AFTER METRAZOL CONVULSIVE THERAPY AND OTHER CONVULSIVE STATES. M. M. Pearson, and H. W. Ostrum. *The American Journal of Roentgenology and Radium Therapy*, XLIV, 726, 1940.

Thirty-two patients undergoing metrazol therapy were studied from the standpoint of damage to the vertebrae. Unlike the usual compression fracture which occurs in the lower thoracic or upper lumbar regions, the compression in these patients undergoing metrazol therapy was found to occur chiefly from the fourth to the seventh thoracic vertebrae. A mechanical cause of the compression fractures is favored by the authors. Of the thirty-two patients, fourteen (43.9 per cent.) showed multiple compression fractures. No correlation between their occurrence and the total number of convulsions, dosage, or age of the patient was found.

The authors make a plea for roentgenographic examination of the spine to be made more frequently after convulsions of any etiology.—*J. D. Blair, M.D., Iowa City, Iowa.*

INSUFFICIENCY FRACTURE OF THE TIBIA RESEMBLING OSTEOGENIC SARCOMA. George E. Pfahler. *The American Journal of Roentgenology and Radium Therapy*, XLV, 209, 1941.

The author first reviews the literature and known facts concerning this type of fracture. He describes it as an incomplete fracture of the cortex of the bone, resulting from

excessive strain and affecting just one side of the bone. In most cases the fracture line is not discernible in the roentgenogram until after a month or more. The first symptom is pain on exertion at the site of the lesion, often with early swelling due to oedema, and with a later swelling caused by callus formation. The process is similar to that seen in the so-called "march fracture" of the metatarsals.

Since the pain and swelling with new-bone formation are often seen without the fracture line being visible, a diagnosis of osteogenic sarcoma is a natural mistake, and one which the author emphasizes as being a tragic one. Cessation of activity and weight-bearing will result in complete cure.

A case report with roentgenograms is also given.—*J. D. Blair, M.D., Iowa City, Iowa.*

RIGENERAZIONE SEGMENTARIA OSSEA MEDIANTE INNESTI ETEROPLASTICI. RICERCHE SPERIMENTALI (Segmentary Regeneration of Bones by Means of Heteroplastic Grafts). Vincenzo Liberti. *Annali Italiani di Chirurgia*, XIX, 389, 1940.

Experiments in animals as well as experience in surgery in man have proved that bone grafts made of foreign material do not take as well or as fast as material from the same animal or individual. The author studied experimentally the question of whether heteroplastic material could be treated before grafting, so that it would take as well as an autoplasmic graft. He resected from the peripheral third of the tibia of rabbits, of the same age and weight, a segment one centimeter long, and implanted in the defect a bone graft taken from the vertebrae of oxen. He used that type of bone because of its spongy structure. Four series of experiments were performed. In the first series, the grafts, after being sterilized by boiling and then drying in air, were immersed for twelve hours in normal saline solution; in the second series, in citrated rabbit's blood; in the third series, in a 2-per-cent. solution of cholesterol in oil; and in the fourth series, in equal parts of rabbit's blood and cholesterol solution. After transplantation of the grafts, the legs were splinted, roentgenograms were taken at regular intervals, and the experiments were finished after two months. The legs were then dissected and examined histologically. While the results in the first two series showed no, or almost no, signs of penetration of the grafts with callus, the third and fourth series showed successful grafting. There was solid union between the two ends of the tibia and the graft, and microscopically a definite reaction of the periosteum and infiltration of the medullary spaces of the transplant with bone tissue had taken place.

The author comes to the conclusion that it is well worth while to do heteroplastic instead of autoplasmic grafting in bone surgery, provided the graft has been previously treated with cholesterol.—*Josef Wolf, M.D., Davenport, Iowa.*

PLASTICHE A DISTANZA CON LAMINE DI GOMMA IN LESIONI SPERIMENTALI DI FASCI NERVOSI (Bridge Plastic with Sheet Rubber in Experimental Lesions of Nerve Bundles). G. Giangrasso. *Annali Italiani di Chirurgia*, XIX, 561, 1940.

While in lesions of the peripheral nerves, suturing end to end is successful in as many as 80 per cent. of the cases, nerve repair, when part of the nerve is missing and has to be bridged, is still unsatisfactory. Since in war wounds this type of injury is quite frequent, new research on this subject is timely. Many methods have been devised to bridge the defect in peripheral nerves without much success. Materials which have been previously used to connect the two ends of the nerve are silk; catgut; autoplasmic, homoplastic, and heteroplastic nerves; and tubes made of bone, glass, an alloy composed of magnesium and aluminum, hardened gelatin, hard rubber tubing, segments of veins and arteries, and the trachea of hens. The author assumes that some of the poor results, when tubes of inorganic material were inserted, are due to the fact that their walls are impermeable for the circulation of nutritional fluid coming from the lymph spaces of the neighboring tissue. Since rubber sheets have proved superior to other foreign material

in arthroplasty (See *The Journal of Bone and Joint Surgery*, XXIII, 206, 1941), the author used it experimentally in nerve lesions. Under local anaesthesia with a solution of 1-per-cent. procaine he dissected from the sciatic nerve of rabbits a piece two centimeters long. Paralysis of the leg, oedema, and trophic ulcers followed. He then implanted a rectangular piece of rubber sheet about four by one and one-half centimeters, and wrapped it around the two ends of the nerve as one rolls a cigarette, sealing it with collodion and stabilizing the "cigarette" by suturing the rubber tube with fine catgut or silk to the perineural tissue. For sheet rubber he used the same material as is in rubber gloves. It was sterilized by boiling in distilled water for thirty minutes, then preserved in a solution of 5-per-cent. phenol, and immediately before use again sterilized by boiling in distilled water for fifteen minutes. Biopsies were performed in the animals, operated upon in the described manner, between ten days and six months after the operation. After three weeks the defect between the two ends of the nerve was completely filled with nerve tissue, which at first showed a rather disordered texture, but later the nerve fibers grew in parallel bundles. In all cases the paralysis, oedema, and trophic ulcers disappeared, and there was complete restitution of function. The method was then used clinically in one patient with a defect of the radial nerve above the elbow joint, with perfect result.—*Josef Wolf, M.D., Davenport, Iowa.*

SULLE CONSEGUENZE DELL'AZIONE DEL FREDDO NELLE EPIFISI DI ANIMALI IN ACCRESCIMENTO (On the Action of Refrigeration upon the Epiphysis of Animals During Growth). G. B. Cengiarotti. *Annali Italiani di Chirurgia*, XIX, 607, 1940.

The pathological and anatomical appearance of an epiphysis damaged during growth by freezing resembles the picture of disturbed epiphyseal growth. However, the nature of the damage, whether caused directly by destruction of the cells or indirectly by impaired circulation, has not been studied before, and is now clarified by the author's experiments. He dissected the lower femoral epiphyses of young rabbits and sprayed them with ethyl chloride for three minutes, after which time the bone was as hard as stone, and of glassy appearance. He let the epiphysis thaw out and repeated the spraying eight to ten times, so that the total time of refrigeration was twenty-five to thirty minutes. Such a procedure proved more satisfactory than prolonged refrigeration for ten consecutive minutes, since the latter caused too much damage to the neighboring tissue and spoiled the experiment. While there were some zones of necrosis and ulceration in the soft tissues, they healed within a short time. The bone lesions were entirely different. During the first two months after the freezing, no change was observed; during the third month macroscopic, microscopic, and roentgenographic changes were visible. The joint cartilage showed cellular disorder,—zones of regular pattern were interspersed with nests of cells of different shapes, pyenotic nuclei, and vacuoles. Furthermore, fatty degeneration and fat embolism of the small blood vessels were evident, and, finally retarded growth, and deformity of the femur. It appears, therefore, that the damage caused by freezing of the growing epiphysis is due to impaired blood circulation.—*Josef Wolf, M.D., Davenport, Iowa.*

PLASTICHE PERITENDINEE SPERIMENTALI CON LAMINE DI GOMMA (Experimental Peritendon Plastic with Sheet Rubber). G. Giangrasso. *Annali Italiani di Chirurgia*, XIX, 766, 1940.

The author studied experimentally the fitness of sheet rubber for artificial tendon sheets. He injected into the Achilles tendon of rabbits a few drops of a culture of staphylococcus pyogenes aureus in broth. The following circumscribed infection healed with a scar firmly connecting the tendon with the neighboring tissue. Six months after the first operation, he excised the scar and wrapped a piece of rubber sheet around the Achilles tendon. The technique was the same as that used for nerve plastic (See abstract, p. 222). Biopsies, performed between two weeks and six months after the second operation, showed that the rubber sheet blocked the growth of the peritendinous tissue

into the tendon, and the tendon had full play within the artificial sheet. The author assumes that this type of alloplastic is superior to any other hitherto employed, and recommends its use, since he feels it has successfully passed the experimental stage in surgery.—*Josef Wolf, M.D., Davenport, Iowa.*

NEUROLOGIC SYNDROMES ACCOMPANYING DEVELOPMENTAL ANOMALIES OF OCCIPITAL BONE, ATLAS AND AXIS. Carl E. List. *Archives of Neurology and Psychiatry*, XLV, 577, 1941.

The author discusses anomalies of the occipitocervical region of the spine and the neurological findings, and reports seven cases. Three mechanisms may be responsible for the neurological signs:

1. Bone deformity causing mechanical compression of the neuraxis.
2. An associated, though independent malformation of the nervous system, not a direct consequence of the bone lesion.
3. A combination of the two foregoing mechanisms.

The bone deformities present in the author's patients were:

1. Malformation of the occipital foramen; basilar impressions (platybasia).
2. Fusion of the atlas with the occiput; malformation of the atlas.
3. Fusion of other cervical vertebrae; malformation of these vertebrae.
4. Abnormal position of the axis in relation to the occiput and atlas.

The author discusses the neurological signs associated with basilar impressions, anterior dislocation of assimilated atlas on axis, and developmental anomalies of the nervous system.

The patient with a congenital deformity of the craniovertebral junction is usually an adolescent or young adult, who complains of suboccipital pains, stiff neck, unsteady gait and signs of progressive tetraparesis of many months' duration. Examination shows a stigmatized person, with an unusually short neck, which is held rigidly, in a rotated or hyperextended posture. Neurological findings consist of tetraparesis combined with cerebellar signs and nystagmus, and occasionally symptoms of increased intracranial pressure. Roentgenograms show bone deformity, especially in the lateral view.

Treatment consists in (1) the decompression of the medulla oblongata and cervical portion of the cord; and (2) immobilization of the head in relation to the neck.

The author operated on six patients; three died of respiratory failure, and three were markedly relieved.—*T. J. Greteman, M.D., Iowa City, Iowa.*

MALIGNANT TUMOURS OF TENDON SHEATHS. E. S. J. King. *The Australian and New Zealand Journal of Surgery*, X, 338, 1941.

Seven cases of synovial sarcomata are described in detail to emphasize the peculiarities of the malignant type of synovial tumor.

In general, the tumors are well delineated and are attached to a tendon sheath originally. After a latent phase, they suddenly increase in size and invade neighboring tissues, occasionally metastasizing to regional lymph nodes, liver, and lungs.

Microscopically, the tumors present a varied appearance, but there is an abundance of closely packed spheroidal or spindle cells with mucoid interstitial material and synovial spaces. These have a lining of connective tissue resembling normal synovial membrane. This lining membrane compares with that found in osteo-arthritic joints, and can be distinguished only by the presence of mitotic figures and by examination of the adjacent tissue.

Local excision of these tumors is unsuccessful, since in six of the seven cases there were recurrences or metastases. Radium implantation, together with wide excision of the tumor mass, has given the only satisfactory results.—*Daniel H. Levinthal, M.D., Chicago, Illinois.*

COMPOUND FRACTURE OF THE LEG. Fay Maclure. *The Australian and New Zealand Journal of Surgery*, X, 354, 1941.

This article, originally presented in October 1939, treats compound injuries from two standpoints,—first, that of generalized shock, and, second, that of the local injury. Shock is treated with transfusions. If primary amputation is necessary, the author prefers a below-the-knee stump of satisfactory length. In secondary amputation for sepsis he prefers a disarticulation through the knee joint, as this procedure requires the least trauma and provides a maximum of drainage. Antitetanus and anti-gas-gangrene sera should be given prophylactically and curatively as well, combined with sulfonamide drugs. Excision and débridement of a wound *en bloc* is the ideal, which cannot often be carried out; hence the author feels that open drainage is next of choice and advocates smearing vaselin or hippo onto the wound to keep it open. In using splints and traction devices, he cautions that the splint must be free-swinging, so that none of the patient's movements during ordinary bed rest will cause motion at the fracture site.—*Daniel H. Levinthal, M.D., Chicago, Illinois.*

A CONSIDERATION OF CERTAIN DIMENSIONAL FACTORS INVOLVED IN THE INTERNAL FIXATION OF THE FEMORAL NECK. D. J. Glissan. *The Australian and New Zealand Journal of Surgery*, X, 368, 1941.

From the premise that two ordinary rustless-steel nails will satisfactorily hold a fractured femoral neck, the author has developed a method for inserting the nails according to predetermined dimensional data. He measured thirty-seven specimen femora to determine the axial length of the neck, practical angle of the neck and shaft, and diameters of the head and neck; but, since these figures vary widely, he finds that they are of use only as minimal and maximal values. The author offers the inner angle of declination as an original contribution. This is the angle formed between the central cervical axis and the transverse axis of the pelvis. This angle is zero when the limb is fully medially rotated; hence the nail can be driven in parallel to the plane of the pelvis. Two nails of a resilient quality offer good fixation without causing as much damage to the bone as a flanged Smith-Petersen nail.—*Daniel H. Levinthal, M.D., Chicago, Illinois.*

COXA PLANA, WITH SPECIAL REFERENCE TO ITS PATHOLOGY AND KINSHIP. H. Jackson Burrows. *The British Journal of Surgery*, XXIX, 23, July 1941.

- "1. Coxa plana proves histologically to be a condition of necrosis of bone followed by repair.
2. The necrosis differs from ordinary aseptic necrosis in showing lysis of trabeculae.
3. Infection cannot be excluded as a cause of the lysis, but is highly improbable.
4. The results of animal experiments suggest that the lysis is not due to arterial anaemia occurring in the special anatomical circumstances of the presence of bone in an envelope of cartilage.
5. A possible cause is some form of vascular disturbance other than arterial anaemia,—either venous obstruction or haematoma; the anatomical circumstances are such that either of these events might have profound results.
6. Recognition of the special pathological changes assists the accurate definition of 'osteochondritis juvenilis' occurring at sites other than the hip and the rejection of alleged examples which lack the essential criteria which might properly justify an analogy with coxa plana.
7. Recognition of histological criteria suggests that the following are akin to coxa plana: osteochondritis of the tarsal scaphoid bone (Köhler's disease), of the metatarsal head (Freiberg's disease or Köhler's second disease), and of the semilunar bone (Kienböck's disease).
8. On grounds of critical radiology, without histological information, it is probable that osteochondritis of the vertebral body in infants (Calvé's disease) and osteochondritis juvenilis of the capitellum (Panner's disease) are further examples.

9. Other alleged examples of osteochondritis juvenilis, with one or two possible exceptions, probably belong to unallied conditions and are not analogous to coxa plana.
10. In assessing these conclusions, only the weight it deserves should be accorded to evidence based on identity of histological appearances or the results of animal experiments."—*Ernest M. Daland, M.D., Boston, Massachusetts.*

ISCHIOFEMORAL ARTHRODESIS. H. A. Brittain. *The British Journal of Surgery*, XXIX, 93, July 1941.

Ischiofemoral arthrodesis is suggested as an alternative method of extra-articular fusion. This procedure can be offered to anybody below sixty-five, provided the operation is to be done for tuberculosis and the disease does not involve the ischium.

It is claimed that a graft of this type gives better support than a graft from the ilium to the greater trochanter. The approach to the ischium is easy, but blind. This procedure is of great use in the patient with smouldering disease, where iliofemoral arthrodesis would stir up the disease.

In 80 per cent. of the thirty-five patients operated upon by this method, bony union took place after one operation. In three patients a second operation was needed. The disease involved the graft in two instances and the operation resulted in a failure.—

Ernest M. Daland, M.D., Boston, Massachusetts.

INTRACAPSULAR FRACTURES OF THE NECK OF THE FEMUR. FINAL RESULTS OF 75 CONSECUTIVE CASES TREATED BY THE CLOSED METHOD OF PINNING. A. L. Eyre-Brooke and K. H. Pridie. *The British Journal of Surgery*, XXIX, 115, July 1941.

This is a study of seventy-five cases treated with the Smith-Petersen pin by the Hey Groves method. All cases were followed for at least twelve months.

In this series the mortality within three months was 5.3 per cent. Signs of necrosis of the head were seen as early as two months and as late as seven months; necrosis occurred in 14.7 per cent. In each of these cases there was a fracture-shaft angle of less than 37 degrees.

In nine cases the method resulted in failure: in six cases (8 per cent.) the pin did not immobilize the fragments; in three cases (4 per cent.) there was suppuration in the wound. Fibrous union occurred in ten cases (13.3 per cent.). The pin was found to have penetrated into the hip joint in four cases. Bony union was obtained in forty-four (58.7 per cent.) of the cases treated.—*Ernest M. Daland, M.D., Boston, Massachusetts.*

TRANSVERSE OSTEOTOMY IN UNUNITED FRACTURES OF THE FEMORAL NECK. S. A. Jahss and B. J. Mintz. *Bulletin of the Hospital for Joint Diseases*, II, 143, 1941.

Sixteen cases of transverse osteotomy for ununited fracture of the femoral neck were studied. The operation is indicated, whether the case is a recent one or not. It may be used even in cases where the head is non-viable. Through an anterolateral incision, the upper end of the femur is osteotomized at the level of the lowest projection of the capital fragment. The shaft is then transposed medially, so that its upper end lies beneath the fracture site, thus eliminating shearing stress.

In 33½ per cent., union occurred across the fracture line, even in cases of long standing. However, where healing of the fracture did not take place, the functional result was still satisfactory.

"The operation is instrumental in relieving pain, restoring stability and effecting recovery of joint motions. It is relatively non-shocking and is adaptable to all age groups with equal safety." Errors in the technique of performing the operation are discussed.—*Henry Milch, M.D., New York, N. Y.*

THE SURGICAL TREATMENT OF LEG LENGTH DISCREPANCIES. Paul H. Harmon and William M. Krigsten. *Illinois Medical Journal*, LXXIX, 300, 1941.

The authors discuss the indications, operative technique, and relative value of three methods used for treatment of leg-length discrepancies: (1) epiphyseal arrest; (2) leg shortening; and (3) leg lengthening. Over 120 patients at the University of Chicago Clinics have had operations for epiphyseal arrest, many having had more than one epiphysis closed. There were no postoperative infections or deaths. In two patients the short leg overgrew the sound leg, but in several, especially in girls, the operation was performed too late to be effective. The tendency has been to arrest growth at the knee in the femur only, but now the authors state they would also fuse the tibial and fibular epiphyses. Epiphyseal arrest should rarely be done after the age of eleven or twelve in girls, and thirteen to fifteen in boys, as very little or no growth can be expected in the long bones.

Thirty-five patients, with more than two inches of shortening, had operative shortening of the femur in the sound side. Except in one case in which infection was followed with loss of bone grafts and slight angulation, the results were excellent, with union in all cases. This method of leg-length equalization is mathematically accurate when properly done, and, although it carries greater operative risk than epiphyseal arrest, it has wide application.

In ten patients, eleven leg-lengthening operations were performed, four on the tibia and seven on the femur. One patient died from cellulitis and septicaemia. In two patients there was massive sequestration of the femoral diaphysis, and in one of these a stiff knee also resulted. Leg lengthening, the authors state, has limited application. They believe it is indicated in certain patients who are short of stature, but should be done only by a limited group of surgeons who have had experience with this method.—

M. S. Friedman, M.D., Iowa City, Iowa.

CALCIUM DEPOSITS IN THE SHOULDER AND SUBACROMIAL BURSITIS. A SURVEY OF 12,122 SHOULDERS. Boardman Marsh Bosworth. *The Journal of the American Medical Association*, CXVI, 2477, 1941.

The author examined, clinically and by roentgenograms, the shoulders of 6,061 unselected persons, and found 165, or 2.7 per cent., of the group had calcium deposits about the shoulder. Of the total group, 5,061 were followed over a three-year period. During this time seventy patients had symptoms of pain in the shoulder. The cases appeared more frequently in males below the age of fifty, and especially in patients whose work required long periods of use of the arms in abduction. The author feels that there is a definite occupational factor in the formation of these deposits. A few deposits were found to occur in as short a time as two months, but it was felt that the majority developed slowly over a number of months.

In diagnosing these cases, the author advocates the use of a fluoroscopic and spot-film roentgenographic technique to prevent the overlooking of otherwise obscure calcium deposits.

In treating these cases, it must be remembered that some will heal spontaneously. Others may be improved or cured by such means as heat (infra-red diathermy) or irrigation methods. The author, however, prefers surgical excision of the deposit as being the surest means of complete relief. After such a procedure, the patient may expect to return to work, without symptoms, in about three weeks.—Louis J. Levy, M.D., Dallas, Texas.

THE USE OF SURFACE ANESTHESIA IN THE TREATMENT OF PAINFUL MOTION. Hans Kraus. *The Journal of the American Medical Association*, CXVI, 2582, 1941.

This paper describes a method of treatment for impaired function, when pain is the factor responsible for the loss of motion or power. The treatment is the application of a surface anaesthetic (ethyl-chloride spray) combined with active motion. It is effective.

tive in: (1) sprains of all joints; (2) acute muscle spasm due to lumbago, acute bursitis of the shoulder, pulled muscles, and so on; and (3) chronic muscle spasm due to "low back pain", sciatica, chronic osteo-arthritis, shoulder spasm, and the like, so long as fractures or a complete tearing of ligaments, muscles, or tendons of the affected region are absent.

The painful region must be determined through active motion, and ethyl chloride sprayed on this area of skin. The patient then starts careful active motion of the part involved in the direction in which the motion has been painful and limited. As the patient carefully increases the movement, new painful areas will develop which should be sprayed. These treatments last from ten to thirty minutes, and immediately following, camphor liniment should be applied to the skin to avoid frostbite. Immediate normal use of the affected part can be allowed in a majority of cases, but excessive strain should be prohibited. The active motion should be continued for approximately five minutes from twice a day to once every hour. One treatment will suffice in minor involvements while several may be necessary in more severe cases.

Immobilization after treatment is contrary to the basic principle, and is never used.

—Brandon Carrell, M.D., Dallas, Texas.

PRIMARY MALIGNANT TUMORS OF BONE. Henry W. Meyerding and Jorge E. Valls. *The Journal of the American Medical Association*, CXVII, 237, 1941.

This study of 424 primary malignant tumors of bone, encountered at The Mayo Clinic during the past twenty-five years ending with 1934, was made in an attempt to evaluate the end results of various types of treatment for these tumors.

The tumors were divided into the following groups: (1) osteogenic sarcoma, (2) fibrosarcoma, (3) Ewing's sarcoma, (4) multiple myeloma, (5) giant-cell sarcoma (malignant), and (6) malignant tumors of bone non-surgically diagnosed as sarcomata without specification of type.

In the treatment of osteogenic sarcoma, surgical operation is the method of choice, as this tumor is highly resistant to irradiation. Irradiation is used mainly to delay growth where amputation or excision is not feasible. The five-year survival rate of these patients who were treated surgically was 23.4 per cent. There were no five-year survivals among the patients treated non-surgically.

The fibrosarcomata constituted a relatively small percentage of the entire series. The authors believe that the fibrosarcomata which occur in bone are more amenable to surgery than are the osteogenic tumors, and the method of choice whenever possible should be biopsy under tourniquet control and immediate amputation. If this is not possible, then radical excision followed by irradiation should be carried out. They point out that a biopsy should be taken wherever possible, and this is particularly true in Ewing's sarcoma. Excision, together with irradiation, or use of Coley's toxins, or all combined, gave survival for five years of 16.7 per cent. of patients who received such treatment. Among the 114 patients treated and traced, 21.2 per cent. survived five years.

The treatment of multiple myeloma was rather discouraging, and treatment proved of little avail. More than 50 per cent. were recognized as multiple at the time of the original examination.

Malignant giant-cell sarcomata accounted for only 1.6 per cent. of the primary malignant growths of bone. At the end of a five-year interval, 83.3 per cent. of the patients had survived. The authors' general impressions are that the roentgenological treatment of tumors is not a cure, yet it has a definite place in the treatment of bone tumors. They are convinced that surgical operation offers the best method of treatment for the majority of primary malignant tumors of bone, and they urge surgeons, roentgenologists, and pathologists to cooperate, believing that only through their combined efforts will diagnosis, prognosis, and therapeutic measures be improved.—H. H. Beckering, M.D., Dallas, Texas.

THE USE OF SULFANILAMIDE AND SULFATHIAZOLE IN ORTHOPEDIC SURGERY. J. Albert Key. *The Journal of the American Medical Association*, CXVII, 409, 1941.

The author reports the use of sulfanilamide and sulfathiazole powders in wounds, either separately or together. He finds that when a mixture of these two drugs is placed into the wounds, the rapidly soluble sulfanilamide gives an initial high concentration of this drug, whereas the more slowly soluble sulfathiazole exerts a more prolonged effect. He has been using these drugs, not only in compound fractures following adequate débridement, but has also been placing them in supposedly clean surgical wounds before closure. The drugs, by their bacteriostatic action, help inhibit infection until the natural body defenses can become effective.

In infected open wounds, after adequate drainage has been established, sulfathiazole, or the sulfanilamide-sulfathiazole mixture is used locally, and supplemented by sulfathiazole orally.

The author feels that hematogenous pyogenic osteomyelitis should be treated with sulfathiazole orally, but that the local infection in the bone should be drained as soon as the general condition of the patient allows operation. He does not feel that sulfathiazole sterilizes the abscesses, and cites a case in which he saw the infection metastasize to other bones while the patient was under sulfathiazole therapy.

In chronic osteomyelitis, sulfathiazole by mouth, over a considerable period of time, may reduce the amount of drainage. Following the work of Dickson and Diveley, the author has introduced sulfathiazole powder in selected cases of chronic osteomyelitis after sequestrectomy and saucerization, with healing by primary intention in fourteen out of seventeen cases. Surgery in such cases is preceded and followed by oral sulfathiazole.—*Louis J. Levy, M.D., Dallas, Texas.*

THE SUPRASPINATUS SYNDROME. SYMPTOMATOLOGY, PATHOLOGY AND REPAIR. David M. Bosworth. *The Journal of the American Medical Association*, CXVII, 422, 1941.

This article is an analysis of fifty-three cases treated by the author with follow-up results for the group. He describes the various types of "internal derangements" of the shoulder which he encountered, and outlines his method of treatment in each case. He explores the shoulder through an inverted L-shaped incision, turning back the deltoid and getting a wide exposure.

The author advocates fusion of the shoulder joint in cases of complete avulsion of the short rotator cuff or in cases of massive fibrillation of the tendons. He reports thirty cases of repaired tears of the supraspinatus tendon. In the treatment of these, the extensiveness of the repair depends on the extensiveness of the lesion, as the end results of mild and radical transplantations were essentially the same.

Seven cases of obliterative subacromial bursitis were treated by surgical severance of the adhesions followed by an abduction spica for six weeks. Good results were obtained in this way in those cases followed.

The author points out that early osteochondritis of the humeral head may present a clinical picture similar to a laceration of the short rotator tendons.—*Louis J. Levy, M.D., Dallas, Texas.*

OCCULT FRACTURES. Roland Hammond and Denis S. O'Connor. *The Journal of the American Medical Association*, CXVII, 500, 1941.

The authors reemphasize the warning given in 1908 by Sir Robert Jones to the effect that clinicians must not depend solely upon roentgenograms for the diagnosis of fractures to the exclusion of clinical judgment.

In spite of the great improvement in roentgenographic technique and interpretation since that time, there yet remain cases in which a fracture cannot be demonstrated, although clinical evidence strongly suggests it and later roentgenographic evidence con-

firms it. Such fractures are defined by the authors as "occult fractures", and they present twelve cases.

The authors advocate continuation of the program of improved education of technicians and better training of practitioners in the interpretation of roentgenographic findings alone or in collaboration with the roentgenologist, but they point out that in case of doubt the clinical findings should always take precedence over negative or inconclusive roentgenographic findings.—*S. L. Stovall, M.D., Dallas, Texas.*

SHOULDER AND ELBOW LESIONS OF THE PROFESSIONAL BASEBALL PITCHER. George E. Bennett. *The Journal of the American Medical Association*, CXVII, 510, 1941.

In discussing the "sore arm" of the professional baseball pitcher, the author divides the lesions of the shoulder into an anterior and a posterior group. In the anterior group are included traumatic irritation, fraying of the supraspinatus and biceps tendons associated with constant rotation of the humerus, similar traumatic irritation of the subacromial and subdeltoid bursae, irritation of the coracoid bursa by the head of the humerus in the "follow-through", and inflammatory processes in the various bursae of this region. Conservative treatment is usually effective and includes rest and the local application of heat, combined with removal of focal infections and improvement of general health in inflammatory conditions.

The characteristic posterior lesion, which may seriously limit the career of the professional pitcher, is an exostosis which develops at the posterior-inferior border of the glenoid fossa, probably due to the repeated strong pull of the triceps and posterior capsule. This deposit produces an irritation of the capsule and its synovial lining, giving rise to local pain and tenderness, and irritates the circumflex nerve, producing referred pain in the deltoid region. Symptoms appear only under the terrific strain of "hard pitching". Rehabilitation of the shoulder so that it can withstand this strain cannot be assured at the present time.

Elbow lesions of the pitcher include the presence of loose bodies in the olecranon and coronoid fossae, and other osteochondritic changes. These may interfere with complete extension of the elbow, but they produce few other symptoms. Surgery is usually successful, and there is little interference with the pitcher's career.—*S. L. Stovall, M.D., Dallas, Texas.*

THE PLIGHT OF THE ARTHRITIC. Russell L. Cecil. *Journal of the Medical Association of Georgia*. p. 318, July 1941.

The author calls attention to the large number of people suffering from chronic rheumatic conditions. He also calls attention to the lack of hospitals or medical facilities available for the care of these patients. Much better care is provided for those suffering from tuberculosis or cancer.

Arthritis is divided into two large groups: (1) the rheumatoid or infectious type, and (2) the degenerative type. Too often the seriousness of Type 1 is overlooked or not sufficiently stressed by the doctor in the early stages of the disease. Much can be done at this stage to prevent the patient from becoming a bedridden or badly crippled invalid. The multiplicity of remedies suggested for treatment is an indication that no specific or eminently satisfactory form of treatment has yet been devised. The most fundamental principle in the care of these patients is rest with the release from ordinary cares and responsibilities of daily life. Sanatoria especially qualified to treat these conditions would be ideal, but unfortunately they do not exist in this country except for a few where patients of considerable means can afford to go. Treatment should continue for at least six months, but the great majority of patients can not afford this. Institutions especially equipped for the study and care of arthritics are needed, as this disease is a public health problem.

Three forms of treatment are in general use: (1) vaccine therapy, (2) vitamin-D

therapy, (3) gold therapy. Each of these is discussed. Gold is a dangerous form of treatment, and requires close observation and frequent examinations of the blood and urine. In spite of its dangers, its beneficial effects seem to justify its use in rheumatoid arthritis.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

EXTERNAL PIN FIXATION FOR FRACTURES OF THE MANDIBLE. Rainsford Mowlem, J. L. Dudley Buxton, Alexander B. MacGregor, and John N. Barron. *The Lancet*, II, 391, October 4, 1941.

The authors describe an apparatus to control fractures of the mandible occurring behind the tooth-bearing area. A pair of crossed Kirschner wires are inserted into each fragment. Methods of locking each pair of wires into a unit and then joining the units to maintain reduction are described. The advantages claimed are: absolute fixation by extra-oral means, oral cleanliness, function at the temporomandibular joint, and simplified feeding. The disadvantage is the occasional necessity of treating the small residual scars. The authors have used the method in nineteen cases. They feel that it is applicable only to chosen cases, and that it should not be used to replace the simpler and more standard methods for the great majority of mandibular fractures. Details of the extra-oral bar are well illustrated both by drawings and photographs.—*Lenox D. Baker, M.D., Durham, North Carolina.*

IRRIGATION OF WOUNDS WITH HOT SULFANILAMIDE SOLUTION. Fred R. Adams. *The Medical Press and Circular*, CCV, 318, 1941.

The author stresses the importance of thorough débridement in any potentially infected wound. Mechanical cleansing following débridement is equally as important. This may be done by soap and water or by irrigations with physiological saline or hypochlorite solution.

The author notes the definite value of powdered sulfanilamide in preventing infection in open wounds, but calls attention to the fact that only 0.8 per cent. of the drug is soluble in the serum of the wound, and the bacteriostatic action is due entirely to the dissolved part, and not to the powder or crystals remaining in the wound.

However, if sulfanilamide is dissolved in water at a temperature of 60 degrees centigrade, a 6-per-cent. solution will result. The author's *in vitro* experiments have demonstrated that this solution at 60 degrees centigrade will destroy organisms found in periapical lesions and in infected root canals in ten seconds contact. Heat increases the bactericidal effect of sulfanilamide, and makes possible a more concentrated solution of the drug. Since the surface tension of a heated solution is lowered, it is possible for the solution to penetrate farther into the involved tissue. It is thus possible to use a heated solution of sulfanilamide in wounds, and to get a greater bacteriostatic or bactericidal power than by using crystals alone. The wound should be irrigated only once with the solution.—*Herbert E. Hipps, M.D., Marlin, Texas.*

THE SEQUELAE TO NERVE INJURIES. Harry Platt. *The Medical Press and Circular*, CCV, 371, 1941.

The disabling aftereffects of a peripheral-nerve injury are dependent on the influence of a number of different factors. Impairment of function due to loss of nerve conduction (paralysis, anaesthesia, paraesthesia) varies considerably in economic significance with the nerve involved. Mechanical aftereffects—such as joint stiffness, flail joints, ulceration, and contractures—naturally also contribute to the sum total of residual disability.

There is a comparatively high percentage of functional recovery following suture of the radial nerve. However, if suture of this nerve fails to restore function, it is better to do the tendon transplantation described by Robert Jones than to re-open the arm and attempt secondary suture.

The median nerve seldom recovers satisfactorily when primarily sutured. Recovery following secondary suture is unknown. The Bunnell-Mayer operation is recommended to restore opposition.

Suture of the ulnar nerve results in very little more recovery than does that of the median nerve. Even though complete recovery does not occur, the lesion is not disabling to the hand for the coarser movements such as are used by laborers; however, in the case of the finer movements of the musician or artist the hand is seriously disabled.

Brachial-plexus injuries are always grave. Traction injuries in adults often leave a seriously crippled limb with very little expectation of recovery.

The sciatic nerve seldom recovers satisfactorily following suture, and in the majority of cases, after ulceration and sepsis, amputation is the only logical procedure.

Tenodesis to correct foot-drop resulting from failure of recovery of the external popliteal nerve is seldom of permanent value and is not nearly so efficacious as the wearing of a walking appliance.—*Herbert E. Hipps, M.D., Marlin, Texas.*

FRACTURES OF THE LOWER END OF THE RADIUS AND ULNA. Arthur G. Ord. *The Medical Press and Circular*, CCV, 496, 1941.

The usual types of fracture and the subsequent deformities are described, and the special complications that are liable to arise are discussed. Tenosynovitis of the tendons of the abductor pollicis, the extensor pollicis longus, and the extensor pollicis brevis is usually due to the excessive tightness of the plaster over the anatomical snuff-box. Persistent numbness of the dorsum of the thumb may result from a similar pressure. Gross persistent oedema of the dorsum of the hand after forty-eight hours is most likely due to "rucking" of the dorsal plaster slab, and, if not immediately corrected, intractable finger stiffness will develop. Delayed union or non-union of the ulnar styloid results in tenderness over this area and weakened grip. Median-nerve injury is rare.

The fracture is reduced by traction, followed by palmar flexion and ulnar deviation. Anterior and posterior plaster splints are then applied. On the fourth day new splints, holding the wrist in 5 to 10 degrees of dorsiflexion, are applied. In a fortnight the plaster is removed and an elastoplast bandage is wound comfortably tight around the wrist.—

Herbert E. Hipps, M.D., Marlin, Texas.

DUPUYTREN'S CONTRACTURE. Arthur Rocyn Jones. *The Medical Press and Circular*, CCVI, 14, 1941.

The author discusses the relative significance of trauma, infection, irritation, and other factors in the causation of this condition, and concludes that it is due to some inborn or acquired predisposition which is encouraged by injury.

The treatment always should begin with the detecting and treating of any constitutional disturbances. If this is done early enough, before much contraction has occurred, frequently stretching and active extension of the fingers will bring about correction of the condition.

More radical treatment necessitates either subcutaneous cutting of the fascial strip or its complete dissection and removal from the palm. Often, in very severe cases, subcutaneous cutting must be done first to get the fingers partially straightened; then later, when more thorough cleansing and preparation of the skin is possible, the open operation can be done.—*Herbert E. Hipps, M.D., Marlin, Texas.*

FRACTURES OF THE PATELLA. G. O. Tippet. *The Medical Press and Circular*, CCVI, 162, 1941.

The author discusses certain little-recognized points in the surgical anatomy of the patella. Among these, he points out that the patella is of little use to the human knee except for protection. The patella is a sesamoid bone in the tendon of the quadriceps,

and many of the fibers of the tendon do not attach to the patella. The patella is shaped to move vertically in the femoral groove. Any irregularity of the posterior patellar surface is, therefore, liable to cause a traumatic arthritis of the knee joint. In a transverse fracture of the patella, the upper fragment is tilted anteriorly at the lower end, due to the attachment of some of the fibers of the suprapatellar tendon to the anterior surface of the bone.

Chip or longitudinal fractures may be treated by extension immobilization with plaster for eight weeks. The patient is permitted to walk.

Transverse fractures always need surgical attention. The torn lateral expansions of the quadriceps tendon should be closed, and the patella pulled together with strong catgut threaded through holes in the fragments. The leg must be immobilized in extension with a plaster cast extending from hip to ankle. The patient may be permitted to walk in a few days.

Comminuted fractures should be operated upon, and all fragments should be removed. The whole patella may be removed if it is extensively comminuted. The fragments should be dissected out from under the tendon and should not be cut out haphazardly. The remaining tendon fragments are sutured together as well as possible, and fascial strips may be used to strengthen the area if necessary. A posterior splint is applied for seven days, and then active flexion and extension of the knee is encouraged.

Compound fractures should always be treated by excision of the fragments.—

Herbert E. Hipps, M.D., Marlin, Texas.

THE LOCAL USE OF SULFATHIAZOLE IN THE TREATMENT OF STAPHYLOCOCCAL INFECTIONS. PRELIMINARY REPORT. W. W. Spink and J. R. Paine. *Minnesota Medicine*, XXIII, 615, 1940.

The authors observed that while blood cultures remained sterile in patients with staphylococcal septicaemia after sulfathiazole had been administered, the organisms could be consistently cultured from localized lesions. Sixteen patients with localized staphylococcal infections were treated by the application of sulfathiazole directly to the lesion every few days in addition to immobilization and elevation of the infected area where possible, surgical drainage and débridement of devitalized tissue, and frequent irrigation of the infected area with warm saline or Dakin's solution to remove necrotic material which has an inhibiting action on sulfathiazole. In patients acutely ill, sulfathiazole was given also by mouth. Sulfathiazole was planted directly in the infected part in crystalline form, or in a one-per-cent. aqueous solution in the form of irrigant or wet pack, or one-per-cent. sulfathiazole suspended in cod-liver oil, or in cod-liver-oil ointment with vaseline base. Very little of the sulfathiazole appeared absorbed from local areas, as analysis of the blood showed only traces of the drug.

Four cases of extensive carbuncles, three cases of infected operative wounds, one decubitus ulcer, one corneal ulcer, two cases of chronic osteomyelitis, one pyopneumothorax, and one extensive subcutaneous abscess were treated by this method with marked success. The successful clinical results obtained justify further investigation of this form of therapy.

The authors quote the results obtained by Jensen and his associates at Minneapolis General Hospital. Primary wound infection developed in no case of their thirty-nine compound fractures treated locally with sulfanilamide, but infections developed in 27 per cent. of their ninety-four cases treated without local sulfanilamide.—*Eugene H. Silverstone, M.D., Iowa City, Iowa.*

THE USE OF GOLD IN RHEUMATOID ARTHRITIS. E. R. Gardner. *Medical Record*, CLIII, 321, 1941.

This paper is a report of 250 cases of rheumatoid arthritis treated in the author's private practice with solganal-B oleosum, a suspension in oil of aurothioglucose, an or-

ganic-gold combination. A course of treatment was initiated with a dose of ten milligrams once weekly for four weeks. This was followed by twenty-five and fifty milligram doses given once weekly for four weeks, and 100 milligrams given once weekly for nine weeks. After an interval of from eight to twelve weeks, a similar course of injections was given. It was necessary to give at least two courses and preferably more to assure a permanent result.

In addition, a dietary regimen of ample vitamin content and caloric value, physical and mental rest, support of acutely inflamed joints, and physiotherapy (hydrotherapy and massage) after the inflammatory stage had subsided were given.

The first symptom to be definitely relieved is pain; then ability to effect joint motion, reduction of the swelling, and improvement of appetite.

Cure was considered to be a return to a condition as nearly normal as the extent of joint destruction would permit. Those patients who experienced relief from pain, but had less increase of mobility than would be expected under the existing degenerative changes, were considered to have reacted favorably, rather than to have been cured.

In this series of cases, 70 to 80 per cent. of the patients responded favorably to treatment, and in 50 per cent. of the recent cases and 30 per cent. of those of over two years' duration, the patients were cured.—*M. Rosenbusch, M.D., Iowa City, Iowa.*

TREATMENT OF CHRONIC ARTHRITIS WITH GOLD SODIUM THIOSULPHATE. John C. Thompson, and C. K. Elliott. *Nebraska State Medical Journal*, XXVI, 44, 1941.

The authors review the literature of gold therapy for chronic arthritis, and report the use of gold sodium thiosulfate in eighteen cases of chronic arthritis over a period of six months. Four patients were given 700 milligrams or more, five, from 250 to 500 milligrams, and the remaining nine, 145 milligrams or less during this interval. Forestier considers that a total of 1500 milligrams should be given in divided doses during one course of treatment, and states that results as a rule are not evident until approximately three months have elapsed and about one gram has been given. Since only four patients of this series had received a sufficient quantity of the drug, the authors draw no conclusions from them and only present the case histories. Three of these four patients had marked clinical improvement and the fourth, at first improved, then suffered a relapse, and later improved again. One patient included in the series had an aggravation of symptoms following each injection, but after the injections were stopped was much better than before they were begun. In two patients an erythematous skin rash with pruritus developed after a single injection. One patient had a marked effusion of the knee joint, which disappeared after twenty-five milligrams of gold had been given.

Various preparations of gold are described. In the author's group of cases gold sodium thiosulfate was used in gradually increasing doses at five-day intervals, starting with ten milligrams and increasing up to twenty-five milligrams.

The minimum amount of the drug which is capable of producing maximum results is slightly over 100 milligrams of gold sodium thiosulfate (the total amount of the drug to be administered in one course of treatment). This may be increased to 1500 or 2000 milligrams if improvement is evident, but developing slowly, and the patient shows no evidence of any serious toxic symptoms.

Based on the reports of others and on their own experience the authors reach the following conclusions:

1. Gold is a potentially dangerous drug, and should be used with knowledge of its toxic reactions.
2. No patient should receive gold who has evidence of any real kidney impairment.
3. Patients giving a history of allergy and hypersensitiveness should be treated cautiously to avoid reactions.
4. Initial doses of gold should be small and later treatment should be the minimum quantity capable of producing a favorable result.
5. Treatment should be controlled by constant and adequate laboratory examina-

tions including blood findings, sedimentation rate, and tests of urine and renal function.

6. The advent of bronchitis, skin eruption, etc. should be viewed with alarm and continued treatment should be given in such cases in very small doses or stopped entirely.—*J. Y. Sher, M.D., Iowa City, Iowa.*

A STATISTICAL AND ROENTGEN ANALYSIS OF TWO HUNDRED CASES OF BONE AND JOINT TUBERCULOSIS. Louis Nathanson and William Cohen. *Radiology*, XXXVI, 550, 1941.

Two hundred cases of proved tuberculosis, selected at random, are reviewed. One-half, from one to sixteen years, were taken from the pediatric service, the rest were adults from sixteen to seventy years.

There were forty-five males to fifty-five females in the pediatric group; seventy-five males to twenty-five females among the adults.

There was no marked difference in incidence according to races.

In the pediatric group, 55 per cent. of the lesions involved the spine, 21 per cent., the hip; in adults, 52 per cent. involved the spine, 18 per cent., the hip. The great preponderance were in weight-bearing bones in both groups.

The pediatric group showed a much larger incidence in the small tubular bones of the hands and feet, while the adult group showed more sacro-iliac and knee-joint involvement.

Vertebral involvement was least in the extremities of the spine, and most frequent from the sixth dorsal to the fifth lumbar. Multiple involvement was a common finding, and occurred more frequently in the pediatric group than in the adult. Osseous and pulmonary tuberculosis frequently occurred together, 42 per cent. of the younger, and 55 per cent. of the adult group having coincidental pulmonary infiltrations.

The marginal type of involvement of the vertebral body was most frequent in the adults. The central type, in which the disc may show no involvement and the joint space no narrowing, occurred usually in the younger group.

Tuberculosis of the shaft of a long bone is infrequent, but did occur, usually in conjunction with involvement of a joint. It resembles non-specific osteomyelitis, and is often a productive lesion.

A paravertebral abscess was demonstrated in 49 per cent. of the cases of spinal involvement in the pediatric, and 71 per cent. in the adult group. Its extension may not follow gravitational lines. It may be the only roentgenographic evidence of underlying bone disease.

In the opinion of the authors the diagnosis of bone and joint tuberculosis from roentgenographic findings alone is not only difficult, but often inconclusive.—*Edward N. Reed, M.D., Santa Monica, California.*

NEWER DRUGS IN TREATMENT OF ARTHRITIS. K. K. Sherwood. *Northwest Medicine*, XXXIX, 452, 1940.

The author states that there are 6,000 treatments for chronic arthritis. For a frankly suppurative joint, sulfanilamide and its derivatives are indicated. In an acute infection there is a marked increase in the need for vitamin C which should supplement sulfanilamide. When inflammation becomes chronic, it is of benefit to simulate an acute attack by producing fever and leukocytosis through typhoid injections. After the disease is arrested, removal of the focal infection will prevent recurrences.

Sulfanilamide is of little value in the proliferative type of arthritis; these patients frequently have an idiosyncrasy to it and occasionally develop marked leukopenia. Removal of foci is of importance in the general health of the patient, but has no specific effect upon the joint itself. Vitamin C is often extremely depleted. One hundred milligrams of ascorbic acid, three times daily, is indicated. It is a matter of weeks before the blood level becomes normal.

Gold is of especial value in the chronic symmetrical atrophic arthritis with normal

white blood count and rapid sedimentation. Ten milligrams of gold thiosulfate, once or twice a week, is very beneficial and relatively inexpensive. Routinely, a check should be made on hemoglobin, white blood count, and urine at least once a month. The author believes that vitamin C protects against gold intoxication, and gives it routinely. Gold administration should be continued until the patient is well, improvement ceases, or signs of intoxication occur. The author has had no fatalities. Liver and kidney disease are contra-indications to the use of gold.

The foremost serious complications are dermatitis, purpura, hematuria, and jaundice. Dermatitis is preceded by itching, and, if the drug is stopped at this stage, the dermatitis will be mild. Purpura is rare; the use of freshly dissolved drug at each administration lessens its possibility. The onset of purpura or bleeding gums is an absolute contra-indication to the further use of gold. In four cases with this complication seen by author, good response was obtained by intramuscular injections of liver and vitamin C. Hematuria was found to occur only in ankylosing spondylitis. The use of gold in the latter condition is rarely good, and hematuria so frequent, that urine analysis is indicated before each dose. One patient receiving a total of twenty milligrams of gold sodium thiosulfate required a transfusion. Jaundice and acute liver atrophy are rare, and probably occur only with large doses. Pain in involved joints after the first few injections is common, and is no contra-indication. Stomatitis may indicate intoxication, but is mild with small doses. Iritis also may occur. Joint oedema with obscure etiology frequently shows deficient vitamin C, and a chemical analysis of the blood should be made. Foci of infection, if evident, should be removed.

Gold, in the absence of rapid sedimentation, and sulfanilamide, and foci removal have not been of value in senile hips or Heberden's nodes. Vitamin B in large doses has been helpful occasionally. It is analgesic and mildly laxative.

Vitamin B is curative in alcoholic and deficiency neuritis. Most cases of neuralgia, however, are due to toxic or focal infectious factors, and satisfactory results with vitamin B are not persistent. Focal removal with or without vaccine therapy is indicated. The author prefers powdered yeast by mouth for the more indefinite neuralgias, and intravenous or intramuscular thiamine for true neuritis.

Structural disintegration of joints requires orthopaedic treatment.—*Eugene H. Silverstone, M.D., Iowa City, Iowa.*

PSEUDOFRACTURES IN DISEASES AFFECTING THE SKELETAL SYSTEM. John D. Camp and J. A. L. McCullough. *Radiology*, XXXVI, 651, 1941.

These pseudofractures are transverse zones of rarification from one millimeter to one centimeter in width affecting various parts of the skeleton and usually symmetrical in distribution. They have been described under various names, among them "pseudofractures", "spontaneous fractures", "march fractures", and "multiple spontaneous idiopathic symmetrical fractures".

They occur (1) in malacic diseases, appearing as a transverse band of decalcification; (2) unassociated with malacic diseases, as fissures through the cortex on one side; or (3) as fusiform callus formation and periosteal reaction only.

Some have considered this a distinct disease entity; the present authors do not.

This condition has been observed in connection with osteomalacia, rickets, celiac disease, sprue, osteogenesis imperfecta, fragilitas ossium, hyperparathyroidism, osteitis deformans, and various other conditions, which cause weakening of the bone framework. It occurs most often in the long bones, usually in connection with excessive strains. Losser believes that there is no gross fracture, but rather the summation of a series of small cracks, comparable to the inflections in a piece of malleable metal, caused by persistent bending back and forth.

There are no characteristic signs or symptoms of pseudofractures.

Treatment is to be directed at correction of any associated disease and protection against excessive strain.—*Edward N. Reed, M.D., Santa Monica, California.*

LATE RESULTS IN BENIGN GIANT-CELL TUMOR OF BONE OBTAINED BY RADIATION THERAPY. T. Leucutia, E. R. Witwer, and George Belanger. *Radiology*, XXXVII, 1, July, 1941.

For the past twenty years giant-cell tumors of bone have been classed as benign, and their treatment has become conservative. Surgical attack by curetting and the use of escharotics combined with irradiation has been the most widely used method, but present trends are toward the use of irradiation alone. This has proved sufficient in several series of cases. It avoids the dangers and other drawbacks of surgical intervention,—a major one of which is the possibility that surgery plus irradiation may occasionally constitute the combination of irritants which cause malignant transformation.

With growing experience the technique of irradiation has changed toward smaller dosage, continued over a longer period of time. Such decrease in dosage has tended to lessen the irradiation reaction of these highly radio-sensitive growths.—*Edward N. Reed, M.D., Santa Monica, California.*

A PROPOSITO DEL OSTEOMA-OSTEOIDE DE JAFFE (About the Osteoid-Osteoma of Jaffe). J. L. Bado e P. L. Ibarz. *Revista Brasileira de Orthopedia e Traumatologia*, II, 139, 1941.

The authors give a historical review of osteoid-osteoma and present two cases with a detailed pathological and roentgenographic study. The authors confirm the findings of Jaffe, recognize the affliction as a clinical entity, and describe four types in accordance with the roentgenographic and histological data: the discrete, circular, rarefied limited type; the circular sequestrum type; the hypercondensed type; and the exostotic type. The only treatment is surgical removal.—*Emanuel Kaplan, M.D., New York, N. Y.*

COSTELLAS CERVICAES (Cervical Ribs). Achilles de Araujo. *Revista Brasileira de Orthopedia e Traumatologia*, II, 186, 1941.

The author presents an extensive study of the problem. The embryology, anatomy, and pathology are treated in some detail, and the bibliography on the subject is varied and includes references in several languages. The author gives a description of a case history of a cervical rib, deriving from the seventh cervical vertebra, which caused a complex syndrome involving the brachial plexus and the cervical sympathetic trunk. The patient suffered attacks of changes of voice, which was probably due to indirect impairment of the recurrent nerve, by compression of the efferent inferior anastomotic branches to the inferior sympathetic cervical ganglion. The surgical removal of the rib is described. Following the removal, the patient made a complete recovery. Photographs, roentgenograms, and drawings add to the lucidity of the subject.—*Emanuel Kaplan, M.D., New York, N. Y.*

LUXACIÓN RECIDIVANTE DE HOMBRO: PUENTE OSTEOPLÁSTICO CÓRACOGLENOIDEO.

OPERACIÓN DE RICARDO FINOCHIETTO (Recurrent Dislocation of the Shoulder: an Osteoplastic Bridge from the Coracoid to the Glenoid. Ricardo Finochietto's Operation). V. J. Bértola. *La Revista de Medicina y Ciencias Afines*, II, 545, 1940.

There are numerous operations for recurrent dislocations of the shoulder and the author mentions several of them. He believes that the best operation is the one which deepens the cavity of the glenoid by means of a bone graft. This operation was described by Ricardo Finochietto in *Semana Medica* in 1939. The present author describes the operation in great detail with many good sketches and drawings illustrating the technique and operative plan. A free bone graft, usually employing a rib, is placed in a notch in the end of the coracoid process, with the other end placed in a hollowed-out area in the scapula just below the glenoid. The technique of the operation offers some technical difficulties, but the author solves them by cutting the subscapularis, and by

employing a new incision which he believes greatly improves the exposure. He makes one other innovation in the operative procedure, and that is a thorough exploration of all the structures in the region of the joint and the correction of any variations from the normal, such as a loose capsule, a torn subscapularis tendon, or other abnormality. The operation is certainly an interesting one, and offers a good method for deepening the glenoid fossa of the shoulder. No statistics are included and no end results are given.—*Louis W. Breck, M.D., El Paso, Texas.*

TRATAMIENTO QUIRÚRGICO DE LA LUXACIÓN CONGÉNITA DE LA RÓTULA (Surgical Treatment of Congenital Dislocation of the Patella). Carlos Urrutia U. *Revista de Ortopedia y Traumatología*, IX, 203, 1940.

The surgical procedures used in the treatment of congenital dislocation of the patella can be grouped as follows: (1) skeletal operations, (2) capsular and ligamentous operations, (3) muscular procedures, and (4) mixed procedures.

The skeletal procedures may be summarized as follows:

1. Correction of the genu valgum, thereby modifying the direction of the pull of the quadriceps tendon.
2. Elevation of the external femoral condyle with a bone block, thereby preventing lateral dislocation of the patella.
3. Deepening of the trochlear canal of the femur.
4. Excision of the patella.

The author merely recounts briefly the techniques of the various procedures, and makes no statements as to the particular indications for each.

The capsular-ligamentous procedures should be done if there is a great laxity of these structures. The main procedure used is the transplantation of the patellar tendon and tibial tubercle medially. This is frequently combined with inclusion of the medial portion of the capsule of the knee. Free fascial grafts may be used to anchor the patella medially.

The muscular procedures consist in transplanting other muscles, such as the sartorius, vastus internus, semimembranosus, and the rectus femoris, into the medial side of the patella, so that the patella, on contraction of the quadriceps, will also be pulled towards the medial femoral condyle.

The mixed procedures are the most effective and complete. These usually consist in transplanting the tibial tubercle and patellar tendon medially on the tibia, combining this with a muscular or ligamentous procedure.

The author reports thirty cases which have been treated surgically, most of them by mixed procedures. No statistical analysis of the results is given, but they were generally very favorable.—*Don King, M.D., San Francisco, California.*

TUMORES ÓSEOS A CÉLULAS GIGANTES (Giant-Cell Tumors of Bone). Domingo T. Muscolo. *Revista de Ortopedia y Traumatología*, IX, 301, 1940.

Giant-cell tumor of bone is typically solitary, seen usually in the upper tibia or lower femur in adults between the ages of twenty and thirty-five. It is characteristically in the epiphysis, but may later invade the metaphysis. Trauma may initiate the formation of a giant-cell tumor, but its etiological importance is decreasing steadily as knowledge concerning these tumors grows. The pathogenesis of these tumors is disputed, the main theories including inflammatory, neoplastic, and endocrine origin. Experimentally, evidence points to a fairly strong endocrine rôle, for parathyroid injections in animals produce areas of giant cells in the bone.

Grossly, these tumors usually occupy the epiphysis of the long bones, grow, expand the cortex, and may extend into the metaphysis. The cavity in the bone is trabeculated. The framework of the tumor is soft and red or yellow, depending on its vascularity, and the center may be necrotic. Microscopically, the characteristic feature is the giant

cell which is of variable size and shape. The stroma is made of numerous capillaries, and round and fusiform cells. The xanthomatous tumors are less malignant than the highly vascular ones. Histological section is advised, for this only can determine whether the tumor is benign or malignant.

The first symptom is pain. Later, expansion of the bone and pathological fracture may occur. Roentgenographically, a solitary multilocular cavity is seen in the epiphysis with no new-bone formation, and with integrity of the periosteum and articular cartilage. The main conditions with which giant-cell tumor are confused are: (1) simple bone cyst, (2) localized osteitis fibrosa cystica, and (3) sarcoma.

Occasionally, a giant-cell tumor undergoes malignant change, but this is very rare. The prognosis is very good, and the recurrences are usually due to faulty surgery. The best treatment consists in careful curettage of the cavity, then packing with bone chips and grafts. Amputation need be done only if the tumor is malignant. Roentgenotherapy should be employed only for tumors inaccessible to surgery, such as those in the vertebrae and skull.—*Don King, M.D., San Francisco, California.*

NEURODOCITIS DEL NERVIÓ CUBITAL EN EL CODO (Ulnar Neuritis at the Elbow). Valentine C. Girardi. *Revista de Ortopedia y Traumatología*, X, 15, 1940.

The commonest cause of ulnar neuritis at the elbow is a posttraumatic cubitus valgus, usually subsequent to a fracture-dislocation of the external humeral condyle. Other less common causes are: (1) non-union of a fracture of the internal humeral condyle, (2) exostoses, (3) chondromatosis, (4) arthritis deformans, (5) periarthritis or ankylosis of the elbow, (6) comminuted fractures of the trochlea. One of the earliest symptoms of ulnar neuritis is weakness of the adductor of the thumb, but after a variable period of time, the full-blown picture of ulnar-nerve palsy ensues. The treatment is entirely surgical. The best procedure is the transplantation of the nerve above the medial epicondyle. This is combined with a supracondylar osteotomy, if cubitus valgus is marked. Various procedures for the anterior transplantation are described,—that is, the nerve may be allowed to lie free in the subcutaneous tissue (Roux), covered with antecubital fascia (Jauregui), or a fascia lata graft (Adson), or the nerve may be transplanted to lie over the anterior surface of the humerus below the common flexor aponeurosis of the internal epicondyle (Gutierrez).

It is to be emphasized that ulnar transplantation should be done early in the course of an ulnar neuritis if optimum recovery of function is anticipated.

The author reports nine cases of delayed ulnar neuritis, all of which were relieved by transplantation of the ulnar nerve.—*Don King, M.D., San Francisco, California.*

ESTUDIO EXPERIMENTAL DE LA LUXACIÓN ROTATORIA DEL ATLAS Y SU APLICACIÓN A LOS CONOCIMIENTOS ACTUALES (Experimental Study of Rotary Luxation of the Atlas). Enrique H. Lagomarsino y Héctor Dal Lago. *Revista de Ortopedia y Traumatología*, X, 121, 1940.

The possible movement in the atlanto-axial articulation is within the arc of 40 degrees, but in this movement, as seen from the side, two-thirds of the articular surfaces are not in contact. The lateral portion of the atlas which goes backward also descends, permitting the portion going forward to remain horizontal. The anatomical construction of the bones prevents locking of the articular surfaces. As long as the odontoid remains intact, the atlas can never be dislocated posteriorly. Based on these observations, the author states that in a rotary dislocation of the atlas the head must be turned at least 60 degrees, that the dislocation is maintained by muscular contraction rather than by bone locking, and that, because of the rotation of the head in a dislocation, a true frontal view of the axis cannot be obtained by transoral roentgenography.

In *unilateral rotary luxation* of the atlanto-axial joint, the roentgenographic appearances are as follows:

The transoral projection will show articular compression of the side in which the wing of the atlas goes backward, a good lateral view (profile) of the side in which the atlas advances, and the axis in the center of the mouth, but rotated 60 degrees as shown by its transverse processes.

The lateral view of the axis will show, by rotation of the mandible, cephalic rotation; loss of contact of one articular surface of the atlas with one surface of the axis; the odontoid apparently dislocated posteriorly, because one wing of the atlas is advanced; and no rotation between the atlas and the occiput.

The lateral view of the atlas will show the axis rotated 60 degrees with respect to the atlas; the odontoid apparently in normal place; and no rotation of the atlas on the occiput.

In *isolated dislocation* of the atlas, a true frontal view of the axis can be obtained by transoral projection. The roentgenographic appearances are as follows:

Articular compression of the side of the atlas which goes backward; a good view of the side which advances; and slight displacement laterally of the odontoid toward the compressed side.

The lateral view shows rotation of the atlanto-axial surfaces; some occipito-atloid rotation; and apparent retrocession of the odontoid.

Unilateral non-rotary dislocation requires the rupture of the transverse ligaments for its production, and is not necessarily fatal, for the odontoid process may also be broken by the injury and will not be able to compress the spinal cord.—*Don King, M.D., San Francisco, California.*

CALCANECTOMIA (DOS OBSERVACIONES). (Excision of the Os Calcis. Report of Two Cases). Sara Satanowsky. *Revista de Ortopedia y Traumatologia*, X, 443, 1941.

Excision of the os calcis is an operation which is rarely performed; its indications are tumor or tuberculosis or osteomyelitis of the bone. The tendo achillis is sutured to the plantar muscles and plantar fascia instead of being attached to the astragalus. Better function is obtained by this procedure, as the force of the muscles is transmitted to the forepart of the foot. After the operation the foot is immobilized in plantar flexion for a period of six to eight weeks.

The author presents two cases in which the os calcis was extirpated. One patient was a man, sixty-six years of age, who, following the operation, was able to walk a mile without discomfort. The other patient, a boy of twelve, walked with a slight limp, and there was marked weakness on plantar flexion of the operated foot. Weight-bearing in Case 1 was started at the end of a month; in Case 2 weight-bearing with a felt pad at the heel was permitted after three months.—*Leon Avila, Jr., M.D., San Salvador, El Salvador, Central America.*

MANIPULATION OF THE DORSAL VERTEBRAE. F. Guy Beauchamp. *Rheumatism*, II, 36, 1940.

Thoracic vertebrae are collectively movable to a lesser extent than the cervical and lumbar vertebrae, but do have greater rotary motion than the latter. In man the extensors of the spine are more powerful than the flexors. Inflammation of these extensor muscles produces weakness and stretching, with a consequent increase of the normal convexity in the thoracic area. As a result of this curve, the spinous processes of the seventh cervical and first thoracic vertebrae become unduly prominent. The head and neck appear to be set forward on the shoulders. In addition, when the condition becomes chronic, there is a marked limitation of motion present.

If the deformity is minimal, such patients may receive great benefit from manipulation. Described and illustrated are the following manipulations: springing up the thoracic vertebrae; freeing the scapula; forced extension of the thoracic vertebrae; and rotation of the thoracic vertebrae. All of them are effective in restoring motion upon carefully selected patients.—*Harold M. Childress, M.D., Charleston, South Carolina.*

TROCHANTERIC FRACTURES. Harry D. Morris. *Southern Medical Journal*, XXXIV, 571, 1941.

On the Tulane Service there were four times as many trochanteric fractures as there were intracapsular fractures of the hip. The mortality rate for trochanteric fractures varied from 24.3 to 39.3 per cent. in various clinics. The patients are usually older than those with true neck fractures. The average age of these patients was seventy-seven years. Under previous treatment with Russell traction or plaster casts, mortality was high (44 per cent.). Many decubitus ulcers occurred; nursing care was difficult and painful, and many stiff joints resulted. It was decided to try internal fixation of these fractures. All patients, without selection, are now operated upon as soon as possible after admission. In fourteen cases the Thornton plate and Smith-Petersen nail were used; two cases were treated by means of a long pin in the medullary cavity, and two by wires and screws. Local anaesthesia was used with all patients except the two with subtrochanteric fractures. Preoperative hypodermics of morphine and scopolamine were given. Roentgenograms of the normal hip, with a marker strapped on, were made to determine the length of the nail to be used. The Smith-Petersen nail was introduced, and its position checked by roentgenograms. Then a Thornton plate was added, on which three Sherman screws were used. Sulfanilamide crystals were used in the wounds in some cases, and the wounds were closed. The advantages of this method are freedom from pain after fixation, and no stiffness in the joints. Nursing care is greatly facilitated; the patient can be up in a rolling chair in a few days; stronger patients can use crutches in three or four weeks. In no patient did a pressure sore develop. The average hospital stay was reduced to twenty-nine and one-half days.

Two failures were due to errors in technique. The mortality was 33⅓ per cent.—

Fred G. Hodgson, M.D., Atlanta, Georgia.

FRACTURES OF THE HUMERUS TREATED BY THE HANGING CAST. R. Arnold Griswold, D. C. Hutcherson, and E. C. Strode. *Southern Medical Journal*, XXXIV, 777, July 1941.

Over 300 cases have been treated by a hanging cast with satisfaction. All ambulatory patients are treated by this method except (1) children with extension supracondylar fractures, and (2) patients with extensive compound fractures which were treated first by skeletal traction, and later by the hanging cast after the danger of severe infection was passed. The method was adapted from that used in Caldwell's clinic in Cincinnati. After reduction of the fracture if necessary, a cast is applied from the knuckles to the axillary fold, with the elbow at right angles. A loop of wire or plaster, to which a sling is attached, is fixed to the cast at the wrist. The cast is allowed to swing free from this sling. The arm is not bandaged to the side, and the patient is instructed to be up and about, not to support the elbow, and to sleep in the Fowler position. Circumduction exercises of the shoulder are encouraged from the start. Fractures in the lower third are put up with the forearm in pronation. The position is checked by roentgenograms after one week. The cast is not advised for fractures of the surgical neck. Results have been more satisfactory by this method than by any other.

Primary open reduction, skeletal fixation, recumbent traction, or abduction methods are rarely necessary.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

TROCHANTERIC OSTEOTOMY FOR UNUNITED FRACTURES OF THE NECK OF THE FEMUR. J. S. Speed and Hugh Smith. *Southern Medical Journal*, XXXIV, 798, August 1941.

For non-union of the neck of the femur three methods of treatment are discussed:

1. Osteosynthesis (bone graft) is suitable for a limited number of cases in which the non-union of the fracture is of not more than two months' duration. The head must be viable, with not too much displacement or absorption of the neck, and the patient must be in good physical condition. The results are very satisfactory when union occurs, as

it does in about 60 to 70 per cent. of the cases. In about 25 per cent. of these patients subsequent osteo-arthritis develops.

2. The reconstruction operations are indicated in the presence of a non-viable head, advanced absorption of the neck, or excessive upward displacement of the trochanter. Approximately 60 per cent. have good or fair results. Dislocation of the neck or trochanter from the acetabulum may occur, and arthritic changes may result in a painful hip or knee joint.

3. Trochanteric osteotomies of either the high intertrochanteric, or the low or Schanz type have the mechanical advantages of:

- a. The weight-bearing pedestal is shifted inward.
- b. The shearing force of the fracture site is reduced, and the fracture line is more horizontal.
- c. Following osteotomy the normal action of the glutei is preserved. In general the osteotomy is preferred to the reconstruction operation because:
 - (1) The operation is simpler and safer for elderly and debilitated patients.
 - (2) The mechanics of osteotomy give better weight-bearing.
 - (3) Subsequent displacement and loss of support are less likely.

4. Functional results are better than from reconstruction operations and approximate osteosynthesis.

5. The number of good and fair results is about 80 per cent.

In the majority of cases high osteotomy is better than low. The technique of the operation is described. There was no mortality in a series of thirty cases. The article is well illustrated.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

CONGENITAL PSEUDARTHROSIS OF TIBIA AND FIBULA. REPORT OF FIFTEEN CASES.

J. Hiram Kite. *Southern Medical Journal*, XXXIV, 1021, October 1941.

The etiology, pathology, and general aspects of the subject are discussed. Then follows a review of fifteen cases seen at the Scottish Rite Hospital. In 8,000 patients under fourteen years of age, the incidence was 0.2 per cent. The bowing of the tibia was usually noticed at birth. In only one case was a fracture present at birth. In more than half of the patients the fracture occurred in the first year of life. One did not occur until the patient was nine years old. Four patients were seen and examined by roentgenograms before the fracture. The condition of the bones is described and illustrated. Four patients had had eleven operations before admission, one of whom had had six operations. Thirteen of the fifteen patients reported were operated upon at the Scottish Rite Hospital. Thirteen of a total of twenty-eight operations resulted in non-union, fourteen in bony union, and one was too recent to report. Three patients had refractures after bony union, but obtained firm union after a second bone graft.

Some authors believe that operation should not be attempted until after puberty, but this author believes the operation should be done in early life, because the leg develops better with use. The successful grafts were in patients from four to fourteen years of age. Various types of bone grafts were used, and the details of the operation are described. External fixation after operation is the most important. The average time the patient was in a plaster cast was nine and seven-tenths months, after which a brace was worn. The brace, which is described, was not removed until the roentgenograms showed good solid bone strong enough to bear the weight of the child. Some patients are still wearing braces. There was usually considerable shortening of the leg, requiring a cork sole two or three inches thick.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

BACK DISABILITIES DUE TO STRAIN OF THE MULTIFIDUS MUSCLE. CASES TREATED BY NOVOCAIN INJECTION. W. K. Livingston. *Western Journal of Surgery, Obstetrics and Gynecology*, XLIX, 259, 1941.

In a series of seventeen cases reported by the author, a definite localization of the "trigger-point" producing back pain was found to be in a small area on each side of the

mid-line of the lower part of the sacrum, in what the author calls the "multifidus triangle". In this area is found the lowermost origin of the multifidus and branches from the first three sacral nerves which supply the muscle in this region. In some cases of low-back disability the essential lesion may be small and local, while the syndrome of widespread muscle spasm, neuritis, and the pain phenomena may be due to secondary reflex disturbances. By accurate localization of the "trigger-point", and by the injection of this area with five to ten cubic centimeters of 2-per-cent. novocain deep into the multifidus, immediate relief of the local and reflex pain is produced. This is partly due to the anaesthetic effect of the novocain solution, and partly to the expanding force of the injection, both of which break down the vicious circle of reflexes. The relief is usually temporary and may be followed in a few days by an increase in symptoms with gradual improvement following. The injections are repeated at varying intervals. The results in five of the patients were classified as failures, four as improved, and eight as cured.

This method is not claimed to be a "cure all", but there is little doubt that the "multifidus triangle" plays an important part in back pain, and that the author has definitely contributed to our knowledge and treatment of back disabilities.—*F. Harold Downing, M.D., Fresno, California.*

THE CLINICAL SIGNIFICANCE OF ACCESSORY BONES OF THE FOOT. A. Gottlieb. M.D. *Western Journal of Surgery, Obstetrics and Gynecology*, XLIX, 452, 1941.

The author believes it is fallacious to regard supernumerary bones in the foot as of mere academic significance, and believes that they are potential sources of pathological manifestations. They may remain dormant and symptomless, but seemingly moderate injury or repeated microtrauma may effect a tear of the fibrous tissue in which each bone piece is invested, or it may induce its separation from the parent bone with which it forms a cartilaginous and capsular union. Four cases are reported:

Case 1. Bifurcated sesamoid became painful after trauma, and was cured by surgical excision.

Case 2. Os trigonum, or separated posterior tubercle of the astragalus, became painful following trauma, and was cured by surgical excision.

Case 3. Os tibiale externum, or accessory scaphoid, with persistent pain following trauma was only partially cured by conservative therapy.

Case 4. Os peroneum, or accessory bone, lateral to the cuboid, became painful after trauma, and was cured by conservative therapy.

These cases demonstrate that these bones are potential sites of traumatic inflammation and functional disturbance, and are subject to surgical correction.—*F. Harold Downing, M.D., Fresno, California.*

ÜBER DIE INJEKTIONSBEHANDLUNG BEI ISCHIAS (The Injection Treatment for Sciatica).

Ernst Vaubel. *Zeitschrift für Rheumaforschung*, IV, 34, 1941.

Many forms of treatment have been used for sciatica or lumbago. While physical measures and baths have frequently given relief, certain cases have required modifications of such treatment. One of the most useful measures in the treatment of severe forms of sciatica has been the injection of local anaesthesia about the lumbar plexus or the sciatic nerve. The way in which the lesion is relieved is not entirely clear nor is the site of injection always the same. As the injecting solution the author uses 0.5 or 0.25 per cent. novocain in hypotonic (0.2 per cent.) sodium chloride. Schleich found that hypotonic sodium-chloride solution had an analgesic action. The combination of hypotonic saline with a weak solution of novocain has been found most effective. Seven cases are reported, most of the patients requiring several injections before they were completely relieved. One received fifteen plexus injections and ten peripheral ones. Physical and medical measures are also used. A review of the literature is given.—*John G. Kuhns, M.D., Boston, Massachusetts.*

The first move is to apply one of these. Roentgenograms are then taken, and skeletal traction is applied if indicated. If the cord is damaged, tidal drainage is instituted without delay.

Skeletal Traction

When the cervical spine is under skeletal traction, correctly applied, the spinal cord is safe.* Until the advent of skeletal traction, the safety of the cord in dangerous cases was a constant source of anxiety; if spared

by the initial injury, the cord was always in danger; if partly damaged, further loss might ensue.

The relief from pain by this measure is always striking, and in those patients afflicted with root pain it is dramatic.

Where cord function has been interrupted, skeletal traction may be so applied as to permit frequent change of the patient's position in bed with safety, thus preventing decubitus. By its use the patient may lie on either side.

Skeletal traction frequently brings about reduction. It should not, however, be relied upon, solely, to effect complete reduction, as in this it is often not successful.

Even when reduction is not accomplished by skeletal traction alone, its use is important to overcome spasm, to align the fragments, and to protect the cord and roots during open reduction. Exceptions to this procedure are the bursting fractures of the atlas (Jefferson's), and the extension fractures and dislocations where skeletal traction is the chief reliance.

The Crutchfield tongs, most easily applied of present-day devices, have slipped on two of the author's patients. In both the dome of the skull was uncommonly flat. In one case the tongs, with thirty-five pounds attached, pulled out during the third day; in the other, with fifteen pounds, the tongs shifted on the twelfth day, and had to be removed. Hoen wires, used in six cases, have proved reliable in the author's hands, provided the wire is correctly applied; but the technique of application

* Towne reports a patient with complete transection of the cord at the fourth cervical vertebra, who exhibited immediate embarrassment of pulse and respiration whenever gentle traction was applied to the head. This is the only exception which the author has found in the literature or in his own experience.



FIG. 1
Adjustable Thomas collar

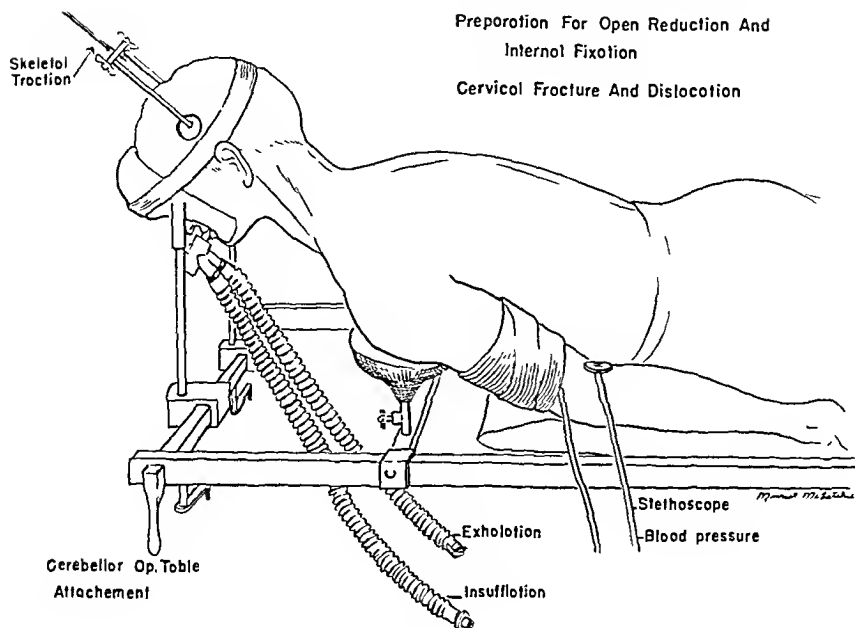


FIG. 2

seems unnecessarily complicated. Both of these methods permit the patient to lie on the side,—a real advantage.

OPEN REDUCTION

If skeletal traction is not successful in effecting reduction, open reduction may be indicated. Closed manipulation has led to cord injury and death. Incomplete closed manipulative reductions may lead to recurrence of deformity, pain, and cord injury. Open reduction gives sight precision. In complex cases, such as those with fragmentation of the neural arch, safety to the cord, during reduction, may be expected only by this means. In dangerous or doubtful cases, the operation is performed with the cervical spine under skeletal traction.

Technique

Intratracheal anaesthesia is decidedly preferable, as is the cerebellar head-rest attachment to the operating table. Skeletal traction is used in case of doubt (Fig. 2). Serious change of position of the involved vertebrae may occur without these precautions.

A mid-line incision is used, which extends upward from the prominent seventh cervical spinous process to the easily palpated second (Fig. 3a), or to the external occipital protuberance if the lesion is high. Through this incision the spinous processes are identified, and those of the involved vertebrae, together with one above and one below, are selected for subperiosteal exposure. The remainder of the exposure is subperiosteal (Fig. 3b). This may be made very easily, by the use of a very sharp, curved, and round-ended periosteum elevator, one-half inch in width. With it the bifid spinous processes are cleared without undue trauma; the

laminae are freed; and the exposure is carried laterally to include the posterior articulations.

Where the neural arch is fractured, the subperiosteal approach is made safe during stripping by steadying the spinous process with a toothed thumb forceps. This may require considerable care, and should never be undertaken without full realization of the danger.

The actual completion of the reduction has not been difficult in any case in this series (Cases 1, 2, and 8), the displaced bone being gently replaced with light, toothed, bone-grasping forceps.

Internal Fixation

In flexion injuries, once reduction has been effected, by whatever method, internal fixation is applied. Prolonged external fixation in cumbersome and often inefficient plaster jackets is frequently a sore trial to the patient, who is sustained in enduring them only by the fear of paralysis or death; and with it recurrences have been frequent.

Internal fixation prevents recurrence, and greatly simplifies convalescence. The appropriate vertebrae are wired together and bone grafts

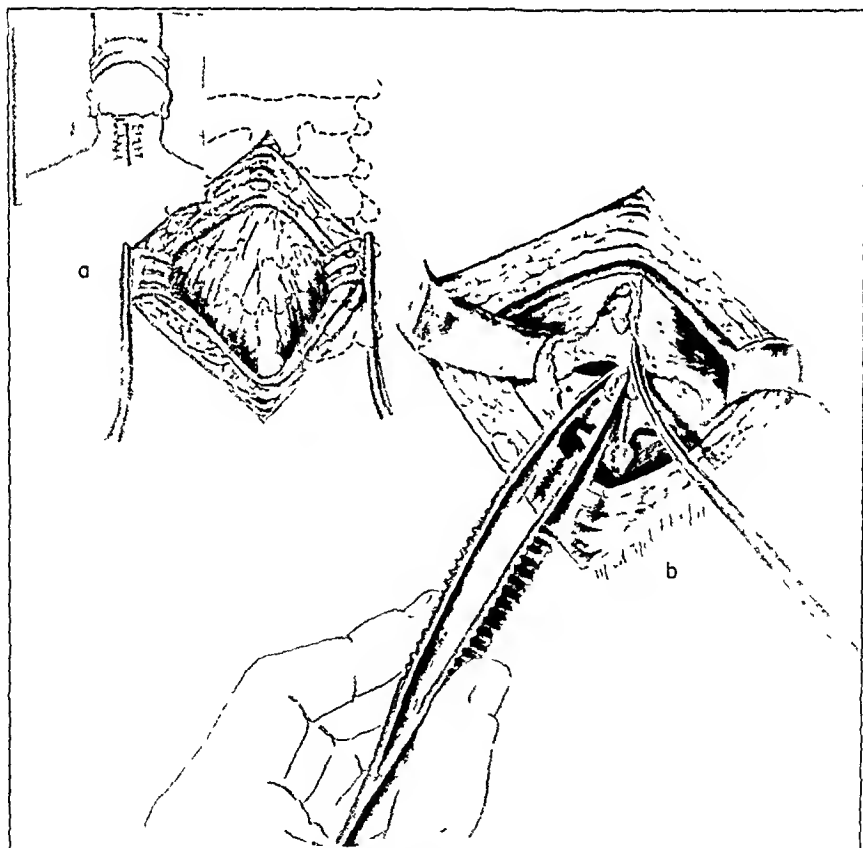


FIG. 3

Open reduction of fracture-dislocation of the cervical spine.

a: Surface anatomy, incision, and identification of spinous processes.

b: Subperiosteal exposure of posterior bone structures.

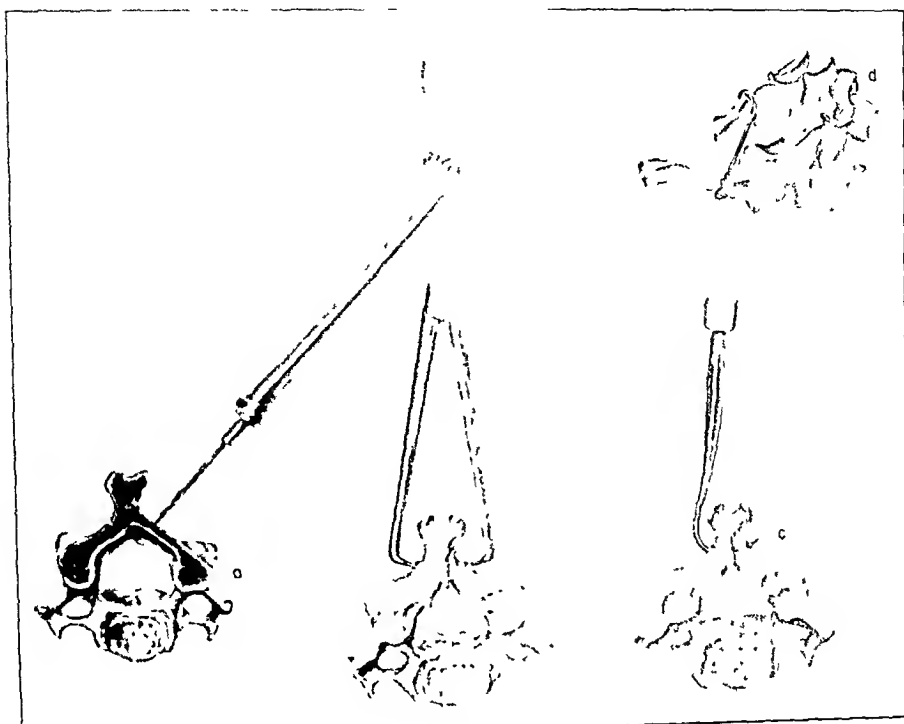


FIG. 4

- a: A small drill hole is made in the outer cortex of the base of the spinous process on each side.
 b: Volsellum forceps are used to complete the transverse hole.
 c: The hole is enlarged with a small hook.
 d: The vertebrae are fixed together with stainless-steel wire.

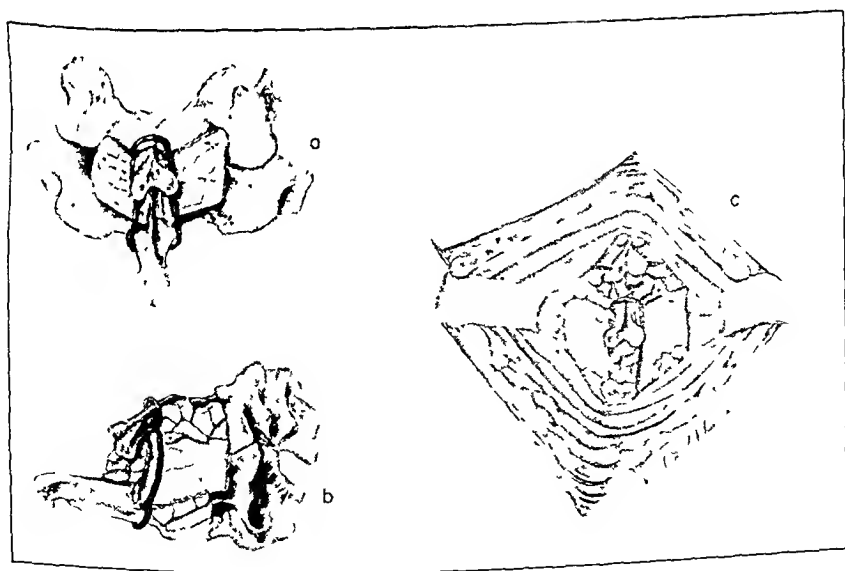


FIG. 5

- a: Shows the manner of applying and fixing the bone grafts for fusion.
 b and c: Bone chips are packed about the osteoperiosteal grafts.

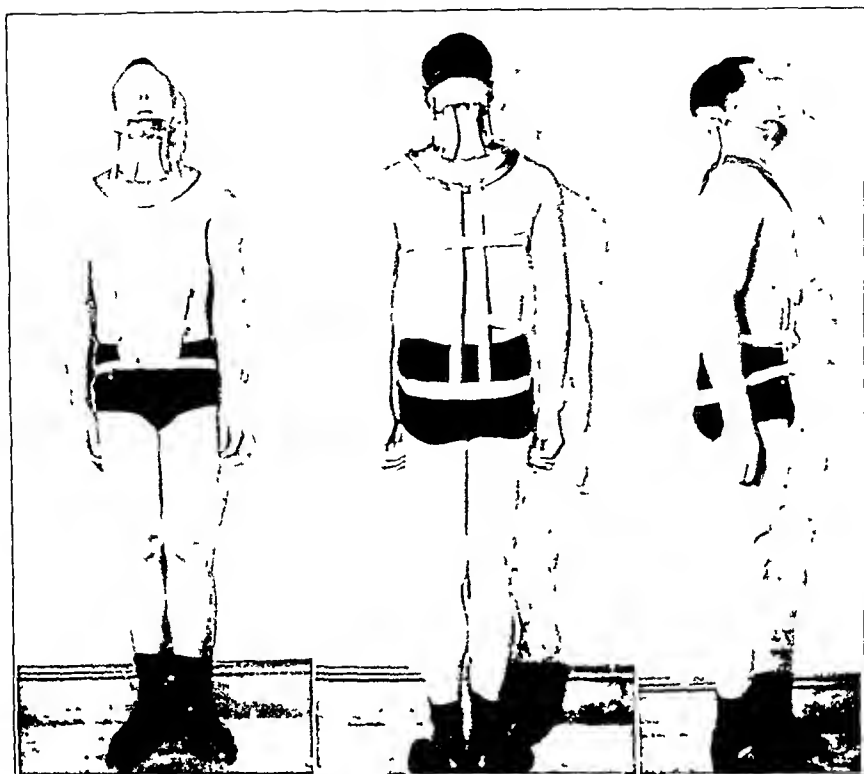


FIG. 6-A

FIG. 6-B

FIG. 6-C

The brace is worn until fusion is complete, to supplement the internal fixation and to prevent the wire from eroding the bone. Without internal fixation the brace cannot be relied upon to prevent recurrence.

are placed so as to bridge the interspinal and interlaminar spaces at the completion of the open reduction. Applied in the manner to be described, and with strict attention to the conditions of convalescence, the wire fixation has held in every instance—eleven cases—and maintained position long enough for fusion to take place.

Babcock stainless-steel wire, No. 24, is satisfactory, and does not cause osteolysis. In each of the spinous processes to be fixed, a small transverse hole is made at the point of junction of the process with the laminae. This may be accomplished with a volsellum forceps or a large beetle-jawed towel clip, since the medulla is not heavily trabeculated (Fig. 4b). The hole is completed with a small hook (Fig. 4c). It is helpful to start the hole with a small drill on the oblique (Fig. 4a). The wire is looped around the superior border of the upper process, and the ends are passed through the hole in that process in opposite directions. The ends are passed distally and parallel across the interspinal space, and then in opposite directions through the hole in the process below. This is repeated until the lowest process to be fixed has been included. One end is then looped around the inferior border of this process; the wire is made snug; and the ends are fastened by twisting (Fig. 4d).

A pair of osteoperiosteal grafts, one on each side, are laid transversely, bridging each interspace. The adjoining portions of the pair



FIG. 7-A

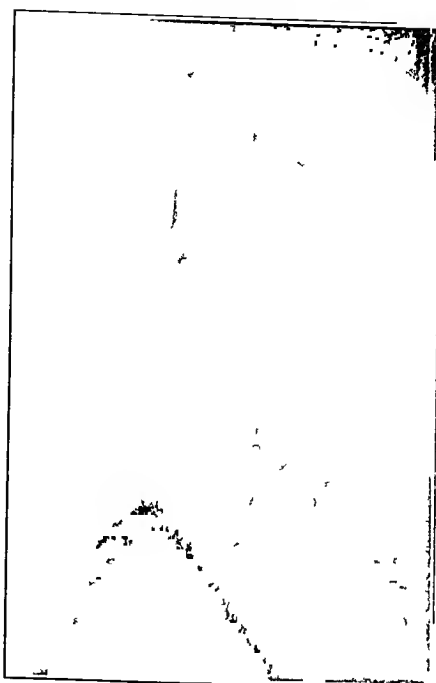


FIG. 7-B

Case 1. On admission. Complete anterior dislocation of the sixth cervical vertebra on the seventh, with temporary quadriplegia.

Fig. 7-A: Crutchfield-tongs traction was employed without obtaining reduction. Complete reduction was obtained by open operation. Skeletal traction was used during the operation.

Fig. 7-B: Roentgenogram taken with patient in hyperflexion shows complete reduction and bony union which was present in four months. Patient returned to work in five months. There was no loss of cord function during treatment and there has been no recurrence of the dislocation.

of grafts are forced between the parallel portions of the wire fixation. In this way, they are held in place (Fig. 5a). Bone chips are packed in wherever possible (Figs. 5b and 5c). There has been no failure of fusion by rigid test in the eleven cases so treated.

Two, and at times three, vertebrae are included in the internal fixation and fusion. In cases of dislocation, the dislocated vertebra is fixed to the one below; in cases of fracture, the fractured vertebra is fixed to the one above,—provided there is bone continuity between the body and spinous process of each. If bone continuity is lacking in either, the next intact arch on the same end is substituted. The problem of selection of the vertebrae to be fused must be carefully studied in the roentgenograms before operation, since spontaneously reduced dislocations or even fractures may be missed. These are suggested in cervical spines, free of degenerative changes, by unexplained narrowing of the intervertebral spaces. Only once has the author found it necessary to fix more than three vertebrae. It is essential to identify, by a portable x-ray unit, during operation, the vertebrae to be fused, if reduction had been effected preoperatively; otherwise the wrong vertebrae may be fused.



FIG. 8-A



FIG. 8-B

Fig. 8-A: Case 6. On admission. Complete anterior dislocation of the fifth cervical vertebra on the sixth with no cord injury. Reduction was obtained by Hoen-wine traction-extension.

Fig. 8-B: Wire fixation of the fifth and sixth cervical vertebrae and fusion operation were performed. Bony union was complete in five months, and the patient returned to work in six months.

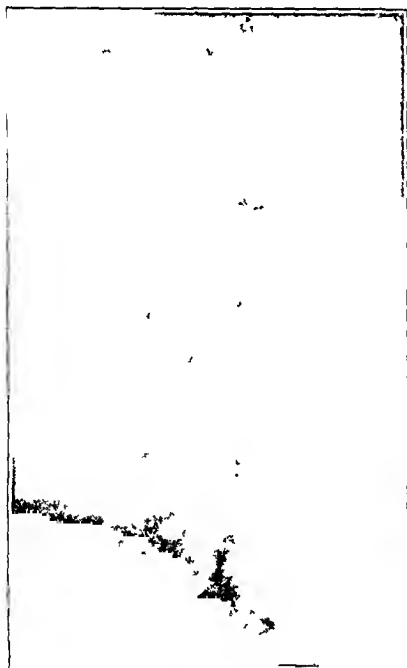


FIG. 9-A

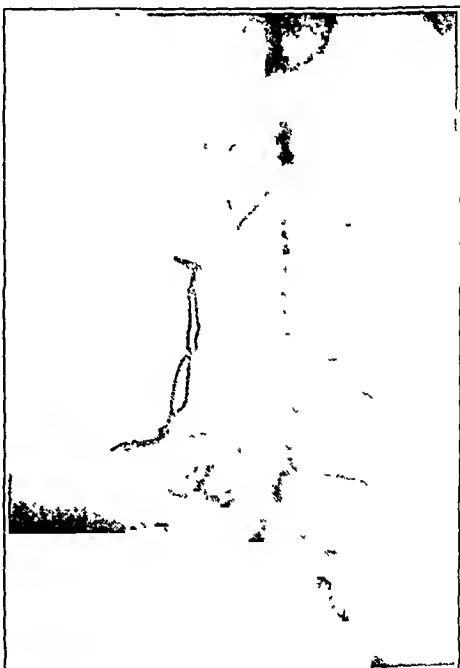


FIG. 9-B

Fig. 9-A: Case 3. On admission. Compression fracture of the body of the fifth cervical vertebra and fracture of the lamina, with temporary quadriplegia. Almost complete reduction was obtained by head-halter traction-extension.

Fig. 9-B: Wire fixation of the fourth, fifth, and sixth cervical vertebrae, and fusion operation were performed. Fusion was complete in three months, and the patient returned to work as a linotyper in two and one-half months.

POSTOPERATIVE COURSE

Patients, with whom there has been no interruption of cord function, have remained recumbent for three to five weeks. If skeletal traction was employed before operation, it is reduced to about five pounds, and is continued during the period of recumbency,—the patient lying upon a flat bed. If skeletal traction was not employed, anterior and posterior plaster shells are used alternately after operation for the same period.

Patients with interruption of cord function should remain recumbent until the neurological condition permits them to be ambulatory.

When patients become ambulatory, the internal fixation is aided by a light and comfortable external support (Figs. 6-A, 6-B, and 6-C). The brace prevents motion of the neck beyond a limited degree. This protects the neural arches of the wired vertebrae from greater tension than they can stand. In all of the cases this protection was employed, and in none was there any pulling through the bone by the wire. The brace is worn until bone fusion is complete.

END RESULTS

Open reduction, internal fixation, and fusion have been employed in a series of eleven cases.

In every case, the internal fixation maintained reduction until fusion was complete, with one exception (Case 4). In this case the dislocated



FIG. 10-A

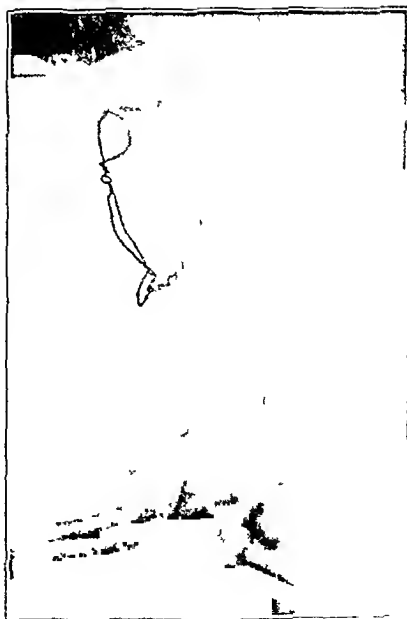


FIG. 10-B

Fig. 10-A: Case 10. On admission. Anterior fracture-dislocation of the second cervical vertebra on the third; compression fracture of the body of the third; no cord symptoms. Almost complete reduction was obtained by head-halter traction-extension.

Fig. 10-B: After wire fixation and fusion operation of the first, second, and third cervical vertebrae were performed, fusion was complete in three months and the patient returned to work in four months.

TABLE I
RÉSUMÉ OF ELEVEN CASES OF FRACTURES AND DISLOCATIONS OF THE CERVICAL SPINE

Case	Type	Cord Injury	Traction	Reduction	Internal Fixation	Fusion Obtained	Approximate Time for Fusion (Months)	Recurrence	Return to Work (Months)	Loss of Cord Function During Treatment
1	Complete anterior dislocation of 6th cervical on 7th	Temporary quadriplegia	Crutchfield tongs	Open, complete	Fusion operation with braided-silk suture of 6th and 7th cervical	Yes	4	No	5	No
2	Compression fracture of body of 5th cervical, with fracture of posterior wall of body	None	Crutchfield tongs	Almost complete by traction; completed at operation	Fusion operation with wire suture of 4th, 5th, and 6th cervical	Yes	3	No	4	No
3	Compression fracture of body of 5th cervical; complete fracture of lamina	Temporary quadriplegia	Traction-extension by head halter	Almost complete by traction	Fusion operation with wire suture of 4th, 5th, and 6th cervical	Yes	3	No	2½	No
4	Partial anterior dislocation of 5th cervical on 6th	None	Crutchfield tongs (slipped) Hoen wire	Complete by traction	Fusion operation with wire suture of the 6th and 7th cervical	Yes	3	Partial	4	No
5	Partial anterior dislocation of 5th cervical on 6th; fracture of spinous process of 5th	Right hemiparesis	Traction-extension by head halter	Complete by traction	Fusion operation with wire suture of 4th, 5th, and 6th cervical	Yes	7	No	8	No

TABLE I (Continued)

6	Old complete anterior dislocation of 5th cervical on 6th	None	Traction-extension by Hoen wire	Complete by traction	Fusion operation with wire suture of 5th and 6th cervical	Yes	5	No	6	No
7	Old unilateral dislocation of 1st cervical on 2nd	None	Traction by head halter	Open, complete	Fusion operation with wire suture of 1st and 2nd cervical	Yes	5	No	5	No
8	Old, complete, anterior dislocation of 1st on 2nd cervical, with fracture of odontoid	Paresis, paresis, anesthesia, hypoaesthesia of 4 extremities	None	Correction to neutral	Craniotomy and laminectomy of 1st cervical; fusion of occiput, 2nd, and 3rd cervical	Yes	6	No	Has not returned to work	Yes
9	Complete anterior dislocation of 5th cervical on 6th	None	Traction by Hoen wires	Complete by traction	Fusion operation with wire suture of 5th and 6th cervical	Yes	4	No	4½	No
10	Anterior fracture-dislocation of 2nd cervical on 3rd; compression fracture of 3rd cervical	None	Traction-extension by head halter	Almost complete by traction	Fusion operation with wire suture of 1st, 2nd, and 3rd cervical	Yes	4	No	5	No
11	Old partial anterior dislocation of 5th cervical on 6th	Right hemiparesis	Hoen wires (broke) Crutchfield tongs	Complete by traction	Fusion operation with wire suture of 5th and 6th cervical	Yes	3½	No	Ataxia unchanged in six months; has not returned to work	No



FIG. 11-A

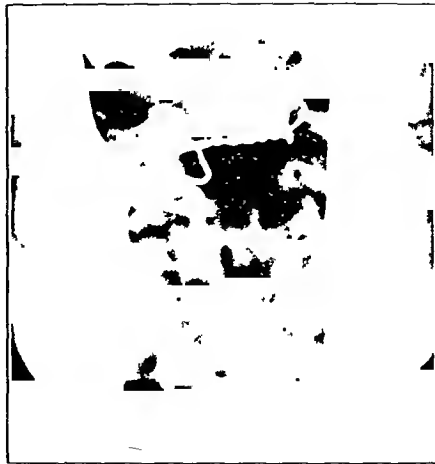


FIG. 11-B

Fig. 11-A: Case 7. On admission. Old unilateral dislocation of the first cervical vertebra on the second; no cord injury. Head-halter traction-extension failed to effect reduction.

Fig. 11-B: Same after open reduction, showing wire fixation and fusion of the first and second cervical vertebrae.



FIG. 11-C

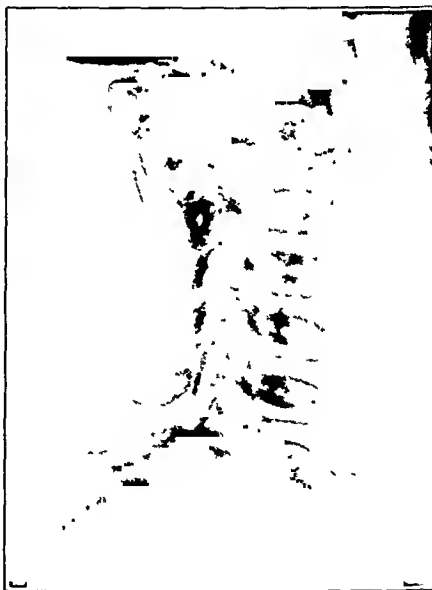


FIG. 11-D

Case 7. Preoperative and postoperative lateral views. Fusion was complete and patient returned to school in five months.

vertebra had been reduced before operation by skeletal traction. At operation it was mistaken for the vertebra above, and the two vertebrae next below were wired together. This error was not detected until three months after operation when roentgenograms revealed a moderate recurrence. Fusion occurred in all eleven cases, judged by lateral roentgenograms taken in maximum flexion and extension. The average time of fusion in the eleven cases was four months.



FIG. 12-A



FIG. 12-B

Fig. 12-A: Case 8. On admission. Old anterior dislocation of the first cervical vertebra on the second, with paresis of the four extremities. Enlargement of the foramen magnum and laminectomy of the first cervical vertebra were performed, with fusion operation of the occiput and the second and third cervical vertebrae.

Fig. 12-B: Fusion was complete in six months; cord symptoms are improving.

There was no loss of cord function during treatment in ten of the eleven cases. Temporary aggravation of cord symptoms was noted in one case immediately following operation,—Case 8, an anterior dislocation of the atlas on the axis with fracture of the odontoid, of nineteen years' duration. Laminectomy and enlargement of the foramen magnum was done by John Hodgson, M.D., of the Neurosurgical Service at the time of fusion, to provide more space in the neural canal. Fusion of the occiput to the second and third cervical spinous processes was done. The patient soon regained lost ground, and is very much better than before the operation.

Nine of the eleven patients returned to their work in an average of five months. The range of motion in rotation varied from 45 to 140 degrees, depending upon the vertebrae fused. (See Table I.)

HISTORICAL REVIEW

In America, Crutchfield and Hoen have pioneered in the field of skeletal traction; and Munro, in tidal drainage. Many others, including McKenzie and Barton, have contributed to our knowledge of skeletal traction. Ryerson and Christopher, reporting a case of internal fixation by wiring and fusion operation in 1937, found in the earlier literature a report of wire fixation by Hadra in 1891, and silk-ligature fixation by Lane in 1892. Known to all is Mixter and Osgood's silk-ligature fixation

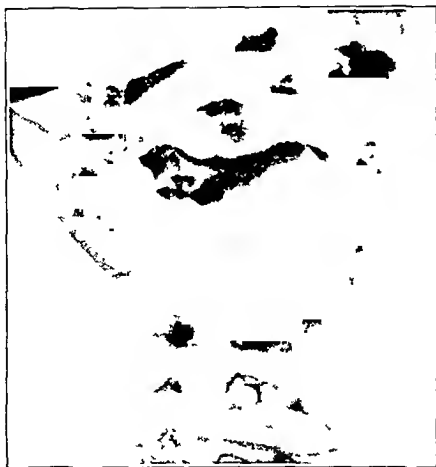


FIG. 11-A

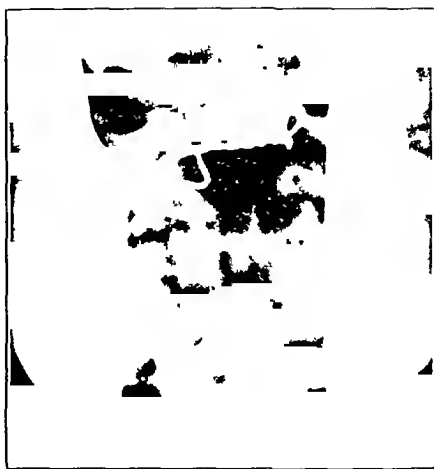


FIG. 11-B

Fig. 11-A: Case 7. On admission. Old unilateral dislocation of the first cervical vertebra on the second; no cord injury. Head-halter traction-extension failed to effect reduction.

Fig. 11-B: Same after open reduction, showing wire fixation and fusion of the first and second cervical vertebrae.



FIG. 11-C



FIG. 11-D

Case 7. Preoperative and postoperative lateral views. Fusion was complete and patient returned to school in five months.

vertebra had been reduced before operation by skeletal traction. At operation it was mistaken for the vertebra above, and the two vertebrae next below were wired together. This error was not detected until three months after operation when roentgenograms revealed a moderate recurrence. Fusion occurred in all eleven cases, judged by lateral roentgenograms taken in maximum flexion and extension. The average time of fusion in the eleven cases was four months.



FIG. 12-A



FIG. 12-B

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in 1910. Later Cotton employed wire in a patient to prevent recurrence. Fusion was reported by De Quervain and Hoessley in 1917, Hibbs in 1922, Krida in 1930, Cone and Turner in 1937, Gallie in 1939, and others. Gallie and Badgley have each accumulated series of cases treated by wire fixation and fusion operation, and Funsten has studied metallic internal fixation in dogs. Open reduction has been performed in the past through the posterior approach by Ryerson and Christopher, Gallie, and others.

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THE POSSIBILITIES OF THE ROENTGENOGRAPHIC STUDY OF THE ARTERIAL CIRCULATION IN THE EARLY DIAGNOSIS OF BONE MALIGNANCY

BY ALBERTO INCLAN, B.S., M.D., F.A.C.S., HAVANA, CUBA

Professor of Orthopaedic Surgery, Havana University

The diagnosis of malignant bone tumors now depends on clinical, pathological, and roentgenographic data.

Arteriography as an additional aid in the diagnosis of malignant bone lesions was first presented by dos Santos, Lamas, and Caldas.¹ Experimental research and clinical application in a series of cases have convinced the author that, if a careful technique is followed, arteriography can be of definite assistance in the early diagnosis of malignant lesions of bone, provided that the lesion is localized so that the early circulatory changes are evident by x-ray. Since it is an accepted fact that the earlier the diagnosis of malignancy is made, the greater are the possibilities of effective treatment, any procedure which will assist in an earlier proof of malignant growth is worthy of consideration. An accurate diagnosis while the neoplasm is still limited to the bone and no invasion of the soft tissues is yet evident offers the advantage of a surgical block resection, as advocated by Albee, a type of operation often accepted by the patient without the hesitancy encountered when an amputation is suggested.

The ability to recognize the important changes demonstrated by this procedure depends largely on a comprehensive knowledge of the appearance of the normal arterial circulation. The arteriographic aspect of an osteogenic sarcoma of the lower third of the femur (Fig. 2-B) is in marked contrast to the appearance of a normal femur of an adult (Fig. 1) after the subcutaneous injection of twenty cubic centimeters of thorotrast into the femoral artery. In the arteriogram the stroma of the tumor, as well as the actual size and area of invasion, can be demonstrated in

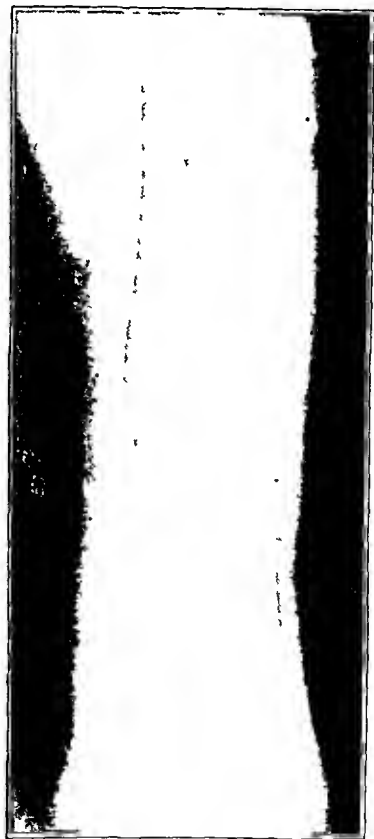


FIG. 1

Arteriogram of normal femoral artery and branches after injection of twenty cubic centimeters of thorotrast.



FIG. 2-A

Roentgenogram of bone lesion of lower third of femur. Roentgenographic diagnosis: bone sarcoma.



FIG. 2-B

Arteriogram of same case as shown in Fig. 2-A. Here the stroma of the tumor and the atypical arterial network with numerous pedicles penetrating the tumor are easily seen, and the neoplastic invasion is clearly demonstrated.

addition to the important arterial changes, whereas a simple roentgenogram (Fig. 2-A) shows only slight signs of a bone tumor.

The question arises as to whether arteriography as a diagnostic procedure can be depended upon to differentiate malignant bone lesions from other pathological conditions of bone. Normal arterial circulation is easily demonstrated. In the study of bone pathology there are two very common variations in the arterial circulation,—ischaemia and hyperaemia.

Ischaemia is usually associated with some of the most common affections of bone,—such as syphilis and chronic osteomyelitis. It is characterized by a lack of normal blood supply in the affected bone, with very few blood vessels surrounding the lesion and those that are visible having the appearance of normal arteries.

Apparent ischaemia may be the result of deficient filling of the arterial branches due to improper technique,—either an insufficient quantity of the injected contrast substance, its slow injection, or the exaggerated speed and rapid evacuation of the contrast medium. Ischaemia may be produced by a mechanical block of the main artery or its branches by extrinsic or intrinsic causes,—as an arteriovenous aneurysm, angiospasm, endarteritis obliterans, or other pathological condition of the vessels. An example of obstruction by a benign fibrous mass is shown in Figure 3.

On the other hand, arteriography may show an increase in circulation due to a pathological bone condition, with numerous normal ramifications of the arteries surrounding the lesion and some enlargement of the arterial branches. This picture is characteristic of hyperaemia,—such as is evident in bone and joint tuberculosis and in other inflammatory conditions of bone.

Therefore, an increase in the normal circulation, hyperaemia, or a decrease of the blood supply, ischaemia, is a definite diagnostic sign in a number of bone lesions any one of which, clinically and roentgenographically, might be mistaken for a malignant bone tumor in the early stage. However, the peculiarities of the abnormal blood circulation observed in neoplasms are sufficiently well defined to differentiate between a benign bone lesion and a malignant bone tumor.

To prove that arteriographic signs of malignancy are present in every case of bone neoplasm and that they are sufficiently prominent to lead to a positive diagnosis in any case of malignant bone lesion, a more extensive experience than that of the author's would be necessary; nevertheless he has found that in every one of his cases in which an arteriographic diagnosis of malignancy was made, the accuracy of that diagnosis has later been verified either by pathological examination or by the clinical course.

The most striking and characteristic arteriographic sign of bone malignancy is the filling in of the stroma of the new growth by numerous vessels, forming an erratic network and showing the extension of the invading tumor. Careful examination of the arteriogram under a magnifying glass enables one to trace these vessels and their irregular, disorderly distribution into the tumor mass. These typical changes are clearly shown in Figure 4.

Another evidence of malignancy is the presence of new atypical arterial circulation with pedicles from the main artery and numerous irregular branches entering the bone lesion. This is an important observation, since it defines clearly the limits of the lesion (Fig. 5). The

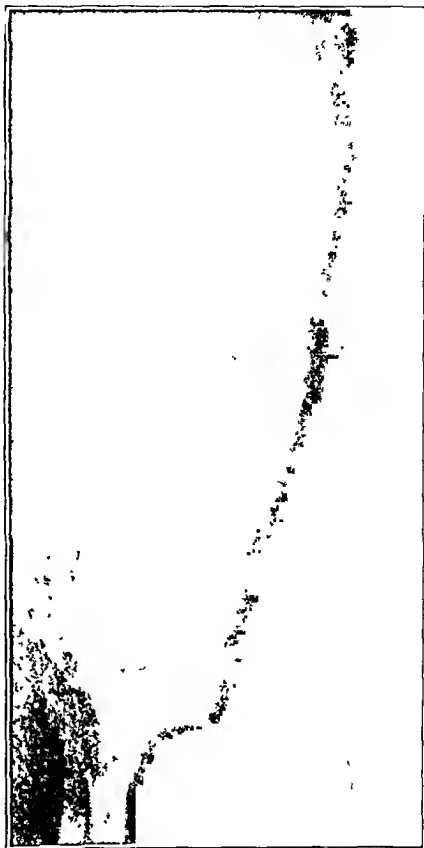


FIG. 3

Arteriogram of femoral obstruction above tumor, showing numerous collateral branches which maintain circulation and surround a large fibrous mass of callus in an old fracture of the femur. There is marked ischaemia in the region of the fracture.



Fig. 6

Venogram showing increased and atypical circulation. Diagnosis: bone sarcoma.



Fig. 5

Arteriogram showing numerous arterial pedicles penetrating the tumor in an atypical and irregular manner,—a most important sign of bone malignancy. Arteriographic diagnosis: osteogenic sarcoma.

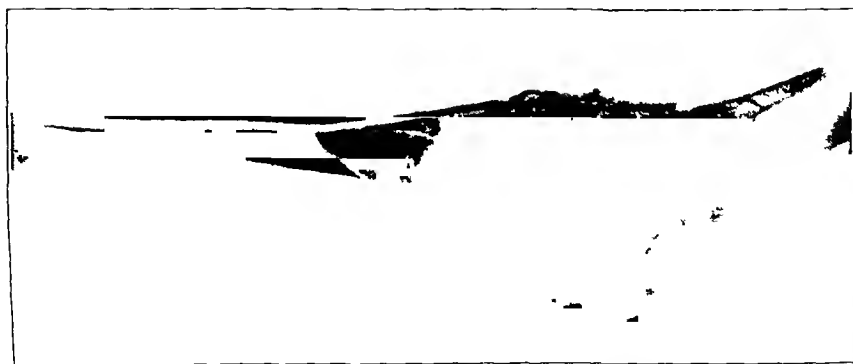


Fig. 4

Arteriogram of malignant bone tumor, showing the filling in of the stroma by newly formed vessels, constituting a network which divides and changes their course in a most atypical and characteristic manner.

premature appearance of very rich venous circulation, with formation of gross venous pedicles arising from the tumor and entering the neighboring vein, is also an important sign. Figure 6 shows this rapid and atypical venous circulation. Another observation, which is evident only in the more advanced cases, is the increased arterial circulation which appears to be distributed perpendicularly to the bone,—actually the early form of the radiating bone spicules characteristic of certain types of osteogenic sarcoma.



FIG. 7

TECHNIQUE

A group of four are required to carry out the technique in making an arteriogram as it is generally followed. One surgeon, with an assistant, is responsible for finding the artery and inserting the needle within it. The artery may be reached by subcutaneous approach or may be exposed. The femoral artery at Scarpa's triangle is usually selected for the lower limbs, although the popliteal or any other main artery may be chosen. For the upper extremities, the brachial artery or the axillary artery is often chosen, but the subclavian artery may be used.

Ascending arteriogram. Uroselectan B (51-per-cent. solution) was injected into the femoral artery, and the vessels below the point of injection were temporarily closed by manual compression of the epigastric region. The deep femoral artery, the external and internal iliac arteries on both sides, and the vertebral arteries are clearly visible. The nutrient artery of the femur can be seen, and the contour of the kidney and the renal artery are also visible.

The same surgeon is responsible for the injection of the contrast substance into the artery. He must block the arterial circulation, either by pressing with one finger just above the point of injection, or by using any other convenient method to obtain temporary occlusion of the vessel during the period of the injection. The substance is injected at the rate of two cubic centimeters per second.

While the injection is being given, the x-ray operator makes three

successive exposures, two of the arterial and one of the venous circulation, using the highest milliamperage possible with the greatest kilovoltage. The time of exposure must be less than one-tenth of a second. An assistant is needed to help in changing the films rapidly.

OVERCOMING THE OBJECTIONS TO THE METHOD

Many criticisms have been published regarding this method of arteriography, but none of them, in the author's opinion, is sufficiently sound or convincing to condemn a procedure which makes possible a positive and early diagnosis of bone malignancy. Any efforts to minimize the possibilities of error and to make the method simpler, so that it may have a place in routine investigation, should be encouraged. Among the factors to be considered are:

1. The need of a sufficiently concentrated and opaque substance to allow the arterial circulation to be definitely shown in the arteriogram.

2. The importance that the substance employed be absolutely harmless and easily eliminated without any unpleasant aftereffects.

3. The necessity that the substance injected always reach the area of the suspected tumor, so that the changes in circulation may be clearly shown in the film.

4. The absolute necessity of obtaining roentgenograms so clear that the finest vessels and the intra-osseous circulation may be readily observed.

5. The importance of avoiding any technical defects which might lead to misinterpretation of the arteriogram and subsequent incorrect diagnosis.



FIG. 8

Ascending arteriogram showing typical signs of malignancy and the invasion of the tumor beyond the humeral limits with the same circulatory changes. This invasion is shown by the upward filling of the axillary and sub-clavian arteries.

The Choice of the Substance to be Injected

In considering the first of these five points it should be remembered that, although the history of arteriography is quite recent, the use of opaque substances aiming toward improvement in the study of the arterial circulation is not new. Although familiar with the reports of the experimental work of dos Santos, Lamas, and Caldas on different opaque substances, the author decided to carry out independent studies, observing several solutions, checking their toxicity as well their opacity. The substances selected for study under identical conditions and used in the same technique were:

- (a) Uroselectan B (commonly used for pyelography).
- (b) Uroselectan B concentrated, 51-per-cent. solution (used for intravenous pyelography).
- (c) Perabrodil (simple).
- (d) Perabrodil concentrated, 50-per-cent. solution, a new formula.
- (e) Thorotrast.
- (f) Lipiodol.

Of these, thorotrast, or thorium dioxide, seems to be the best choice for arteriography. If this substance is used in doses of 10 to 20 cubic centimeters, the carcinogenic property of this radio-active substance seems to be nullified.

It should be recorded that perabrodil (50-per-cent. solution) has been used in five cases, without any great discomfort, and in our experimental work it has also appeared to be less painful than is uroselectan B concentrated.

Although lipiodol offers a wonderful contrast, the injection of this substance into the artery is most



FIG. 9

Showing method of ascending aortography in a dog after catheterization of the femoral artery, using a 70-per-cent. solution of diodrast. (Courtesy of Dr. P. L. Farinas and the American Journal of Roentgenology and Radium Therapy.²)



FIG. 10

Roentgenogram showing tumor mass on lower aspect of condyle. In this case pain and swelling were noted one month after trauma to the knee. Clinical diagnosis: probable malignant bone tumor. Roentgenographic diagnosis: osteogenic sclerosing bone sarcoma.



FIG. 11

Arteriogram showing positive signs of bone malignancy. A new arterial pedicle has been formed well above the zone of the tumor and extending to its anterior aspect.

difficult,—the filling of the vessel is not uniform, resulting in intermittent filling of the artery. Moreover, in some cases it is retained for a period of time, in one case for more than a week, and there is always the risk of embolism when this product is used.

The Ascending Arteriogram

A very important limitation to this method of arteriography is the one referred to in our third point. The suspected bone tumor is sometimes located in regions which the opaque substance cannot reach by the usual technique of injection,—for instance, about the hip, the shoulder, or the spinal column. It is recognized that arteriography may be used in any of the large vessels. Aortography has been employed by dos Santos, Lamas, and Caldas for abdominal diagnosis; the internal carotid may be injected for cerebral angiography; and hepatography is well known. However, the use of these procedures entails greater difficulties than those encountered when more accessible vessels are used.

In the author's effort to improve upon the technique employed in such cases, he has developed the ascending arteriography in which he has been able to inject against the arterial stream and obtain the filling of the



FIG. 12-A

Roentgenogram showing tumor mass on lower third of femur invading popliteal space. There was a history of pain and swelling of two months' duration. Roentgenographic diagnosis: osteogenic sarcoma.



FIG. 12-B

Same femur after a pathological fracture. Arteriogram showing evidence of bone malignancy.

arteries away from the point of injection. Figure 7 shows how well the ascending arteriogram visualizes the abdominal, spinal, and renal circulations in a dog. This arteriogram was taken while uroselectan B was being injected into the femoral artery, against the normal direction of the blood stream, pressure on the descending aorta meanwhile interrupting the arterial circulation.

In the case illustrated by Figure 8, an ascending arteriogram was made to demonstrate a malignant bone tumor of the upper end of the humerus. Ascending aortography has been performed by Fariñas by introducing a long, thin catheter into the femoral artery and carrying it upward to the descending aorta (Fig. 9).

If it is necessary to obtain an arteriogram which will show the smaller arterial branches of a certain area in greater detail, this may be done by limiting the filling of the arteries to that region and obstructing the passage of the opaque substance from it.

The Bucky Diaphragm

While the author is well satisfied with the technique which has been followed by the roentgenologist, he believes that the use of an extra fast

Bucky diaphragm would greatly improve the roentgenographic details of the arterial circulation.

Errors to be Avoided

Any defect in the technique may lead to complete failure to obtain the arteriogram or the complementary venogram. The errors most frequently made are as follows:

1. Mistakes may be made while trying to enter the artery,—such as placing the needle in the femoral vein. In this case the contrast substance will be carried into the venous circulation and the arteriogram will be a failure.

2. If the needle, when placed in the artery, is either withdrawn or pushed through both walls at the time of injection, the films will not define the vascular tree but will show the accumulation of the extravasated opaque substance around the site of injection.

3. The injection may be either too slow or too fast, owing to lack of or excess of pressure, or because a very narrow or a very wide needle is used. To overcome this difficulty, dos Santos has developed an injector of his own design. The width of the needle has also been standardized,—another improvement. The author has not used any particular type of injector, but has always selected a sterilized twenty-cubic-centimeter serum syringe with a large platinum needle. He has measured and repeatedly practised the speed for injection, counting in seconds to obtain the correct amount of pressure so that the twenty cubic centimeters of fluid contained in the syringe would be injected in ten seconds.

4. The lack of synchronization between the injection and the x-ray exposure is noticeable (an automatic switch for the x-ray exposure might help to correct this defect). Exact timing is most essential, because, if the exposure is done too rapidly, the arteriogram will not show sufficient filling of the arteries to justify a proper diagnosis. If it is performed too slowly, the venous circulation will appear at the same time as the arterial circulation, making the reading of the film most difficult.

5. If the compression is not maintained during the period of injection, the opaque substance will be carried out by the blood stream and little or none will be evident in the arteriogram. It is important that the exposure for the venous circulation be made immediately after the pressure is released; otherwise the venous circulation will not be registered.

6. Motion on the part of the patient will cause blurred roentgenograms, unsuitable for diagnosis. To avoid such accidents, general anaesthesia has been recommended when painful substances are to be injected. However, the author has used general anaesthesia only in small children, as experience has shown that the injection of thorotrast is practically painless and the normal adult easily tolerates the burning sensation produced by perabrodil, concentrated.

The illustrations show the characteristic aspects of the arterial circulation in different types of bone neoplasm.

CONCLUSIONS

Arteriography is of importance and practical value in the differential diagnosis of borderline lesions of bone. It will reveal and clearly determine the malignant or benign character of the lesion, and it thus becomes of primary consideration in the early diagnosis of bone malignancy.

The advantages of arteriography as a method for the early diagnosis of bone malignancy are dependent primarily on how early in the disease this form of investigation is undertaken. Arteriography will afford a definite diagnosis of a bone neoplasm in an accessible region when the contrast obtained by the opaque substance used is clear and the technique employed is so exact that the slightest deviation from normal in the arterial circulation is detectable.

The author has found, from both clinical and experimental work, that the use of ascending arteriography broadens the field for the employment of this method of investigation, since it may be employed when the use of descending arteriography would be either impractical or impossible. .

This procedure deserves further trial, especially in large institutions devoted to the study of cancer, where its real value may be ascertained. All contributions leading to a better understanding of this method and the minimizing of the errors in technique should be encouraged, so as to make possible a complete evaluation of its present and future possibilities as a diagnostic aid.

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FRACTURES OF THE LATERAL CONDYLE OF THE LOWER END OF THE HUMERUS WITH COMPLICATIONS

A SIMPLE TECHNIQUE FOR CLOSED REDUCTION OF CAPITELLAR FRACTURE

BY M. G. KINI, M.C., M.B., M.CH. (ORTH.), F.B.C.S.E., MADRAS, SOUTH INDIA

From King George Hospital, Vizagapatam, South India

Supracondylar fractures are common in South India and various types have been encountered which give rise to difficulty in reduction and in the restoration of function. The most difficult type is the fracture of the lateral condyle, which in children is called the capitellar fracture. This fracture is interesting because it is not common.

The cause of this fracture, and the pathological anatomy of displacement of the fragments, have not been clearly understood, and there are very few authenticated reports which show the difficulties in treating the complications, or the results of follow-up. In an analysis of thirteen cases of fracture of the lateral condyle, three were in adults and ten in children ranging from four to twelve years of age, with an average age of seven years. Seven fractures occurred on the left side, and six on the right.

Stimson has stated: "It is easy to produce a fracture by adduction of the extended forearm in bodies of the young or by a blow upon the palm with the elbow flexed at a right angle." This adduction causes strain upon the lateral ligament and the muscles that take origin from the epicondyle. This seems to be a reasonable explanation of the mechanism of the fracture.

PATHOLOGICAL ANATOMY

Various types of displacement occur with this fracture. The simplest in this series was a lateral and upward tilt of the capitellar fragment, and the most severe, a complete displacement in which the capitellar fragment turned a somersault within the joint (Figs. 1-A, 2-A, 2-B, 3-A, and 4-A).

Wilson⁶ has stated: "This displacement is due to the contraction of the long extensor muscles of the wrist and fingers, which take their origin, by means of a common tendon, from the lateral condyle of the humerus"; but the author, in experiments upon cadavera in which all the muscles of the elbow joint were removed, with the exception of the origin and insertion of the brachioradialis and extensores carpi radialis, found that when a fracture was produced beneath the origin of the extensor carpi radialis longus and extensor carpi radialis brevis, the condylar fragment was tilted outward and upward without any marked displacement, and that this occurred in supination only. On pronation the fragments came together easily.

When the fracture occurred with the avulsion of the fragment and both the extensors, the displacement was a little more exaggerated than before, but the fragment did not turn over until the anterior and posterior parts of the capsule were also torn with it, and the forearm was in marked adduction. In this condition the typical displacement seen in roentgenograms occurred. The displacement is of a rotational character in which the articular surface is directed medially and upward, and the fractured surface is pointed backward, laterally, and downward, so that the upper end of the capitellar fragment is directed downward and the lower end upward. The line of fracture is usually from above downward, and, directed medially toward the trochlear surface, extends from the lower end of the diphyysis of the humerus through the epiphyseal cartilage to the articular end. In some cases of adult fractures, the displacement of the fragment is more backward, simulating a dislocation of the elbow (Case 2).

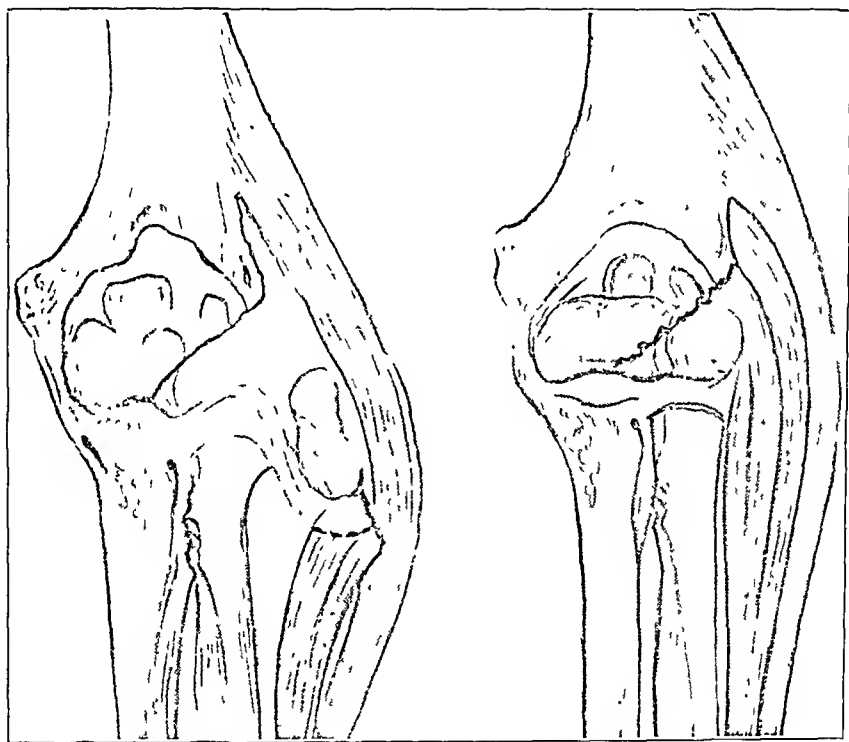


FIG. 1-A

FIG. 1-B

Drawings illustrate capitellar fractures.

FIG. 1-A: The fracture occurred above the origins of the extensor carpi radialis longus and extensor carpi radialis brevis. The displacement of the fragment is shown. Note that the upper end of the lower fragment is pulled down and is pointing downward, slightly backward, and outward, while the lower end is directed medially and upward.

FIG. 1-B: The fracture occurred beneath the origins of the extensor carpi radialis longus and extensor carpi radialis brevis. Only the line of fracture, not the displacement, is shown. Usually the lower fragment is displaced slightly outward and upward.

RÉSUMÉ OF FRACTURES OF THE LATERAL CONDYLE

Case No.	Year	Sex	Age (Years)	Cause and Site of Injury	Duration	X-Ray Findings	Treatment	Result
1	1931	Male	10	Fall from a height on outstretched hand. Left elbow.	20 Days	Capitellar fracture of the lower end of the humerus with slight displacement upward and laterally.	Manipulated under anaesthesia and the flexed elbow put in plaster.	Functional result good at time of discharge.
2	1931	Female	50	Fall from a height. Right elbow.	1 Day	Condylar fracture with backward displacement of the condyle.	Under anaesthesia elbow was flexed and put in plaster.	Result not known.
3	1934	Male	51	Accident when 7 years of age. Left elbow. (Admitted for cubitus valgus deformity and non-union of old capitellar fracture with ulnar paralysis.)	Ulnar paralysis for 3 years before admission.	Old capitellar fracture with non-union.	Ulnar transposition was advised, but patient refused operative interference.	Invalided out of service.
4	1937	Female	7	Fall from a staircase. Left elbow.	1 Day	Capitellar fracture with displacement of fragment.	First admission: Arm put in extension in a Thomas arm splint and after 3 days the elbow was manipulated and put in flexion in plaster. Second admission: Ulnar anterior transposition of the nerve.	Fair at time of discharge, with flexion to 60 degrees and extension to 130 degrees. Readmitted after 2 months for non-improvement of range of movement at the elbow and a trophic ulcer on the tip of the little finger. After the operation there was remarkable improvement in the range of movement of the elbow. One year later elbow appeared normal except for a slight exaggeration of cubitus valgus deformity.
5	1937	Male	12	Fall on outstretched hand after a pull. Left elbow.	1 Day	Capitellar fracture without displacement.	Elbow manipulated and put in flexion in plaster.	Good at time of discharge.
6	1937	Male	11	Fall while riding a bicycle. Left elbow.	2 Days	Capitellar fracture with a somersault of the fragment in the elbow joint.	Arm put in extension in a Thomas arm splint and after 3 days the elbow was manipulated and put in flexion in plaster.	After one year slight limitation of extension and slight exaggeration of cubitus valgus deformity. No involvement of ulnar nerve.

7	1937	Female	7	Fall from a height. Right elbow. (Admitted with a cubitus varus deformity with slight limitation in extension and flexion.)	3 Months	Old fracture of the capitellum with malunion of the fragment.	Advised weight-bearing exercises and massage.	Cubitus varus deformity.
8	1937	Male	4	Fall from a bus. Left elbow.	1 Day	Capitellar fracture with slight displacement of fragment.	Elbow manipulated under an anaesthetic and limb put in flexion in plaster.	Functional result good at time of discharge.
9	1938	Male	4	Fall from a staircase. Right elbow.	3 Days	Capitellar fracture with a somersault of the fragment in the joint.	Arm put in extension in a Thomas arm splint and after 3 days the elbow was manipulated and put in flexion in plaster.	Good.
10	1938	Male	11	Fall from a tree. Left elbow. (Admitted for limitation of flexion.)	2½ Months	Malunion of capitellar fracture.	Ulnar anterior transposition of nerve, manipulation, and elbow put in plaster in flexion.	Slight exaggeration of cubitus valgus deformity. Stated in letter that function is good.
11	1938	Male	30	Fall from a height. Right elbow.	10 Days	Condylar fracture with slight upward and lateral displacement.	Extension of elbow by skeletal traction by Kirschner's wire for 4 weeks, and then gradual active flexion with plaster casing at each stage of flexion to prevent effusion until acute flexion is obtained.	Four months after treatment there was flexion of 60 degrees and extension of 130 degrees.
12	1938	Male	12	Fall from a tree. Right elbow. (Admitted for limitation of movements at elbow with marked new bone formation.)	4 Months	Malunion of fragment with marked new bone formation simulating myositis ossificans.	Manipulated under anaesthesia and limb put in flexion.	Slight exaggeration of cubitus valgus deformity. Reported after one year that result was good.
13	1939	Male	7	Fall from a bench. Right elbow.	2 Days	Capitellar fracture with marked displacement.	Arm put in Thomas extension splint for 2 days until the swelling subsided. Later, under ethyl chloride ether anaesthesia, the fragment was manipulated into position and the limb put in plaster.	At time of discharge there was flexion to 40 degrees, extension to 120 degrees. Subsequently by letter stated that the movements at the elbow were normal.

DIAGNOSIS

The signs and symptoms are like those of any other supracondylar fracture, with the important physical sign of swelling being more marked on the lateral aspect of the elbow joint. When the patient seeks advice twenty-four hours after the occurrence of the fracture, the diagnosis be-

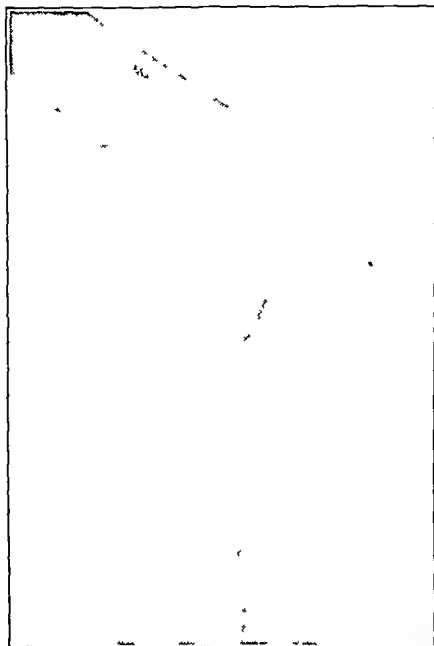


FIG. 2-A

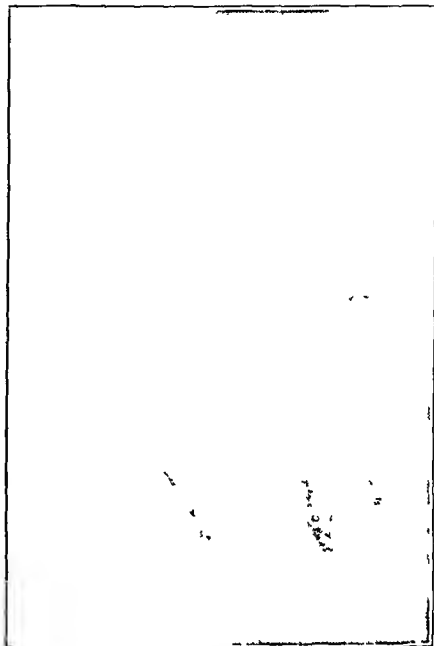


FIG. 2-B

Case 4 October 28, 1937. A capitellar fracture with a displacement similar to that in Fig. 1-A.



FIG. 2-C

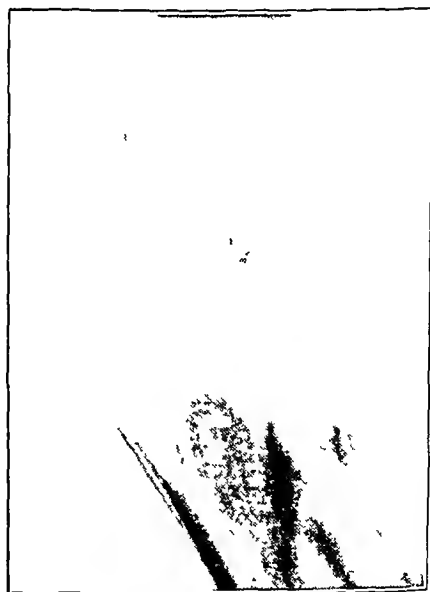


FIG. 2-D

Case 4. October 28, 1937. The result immediately after closed reduction.

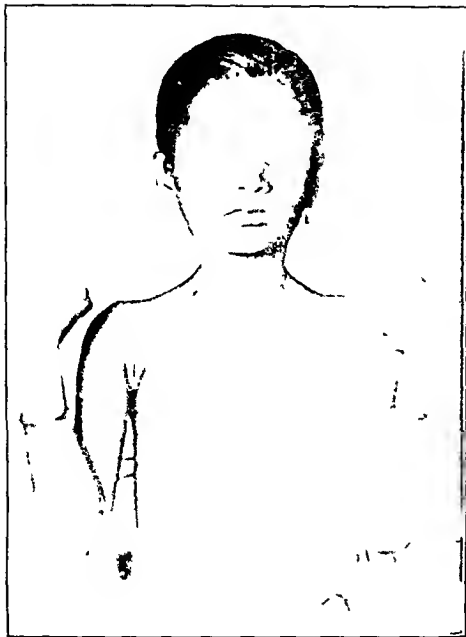


FIG. 2-E

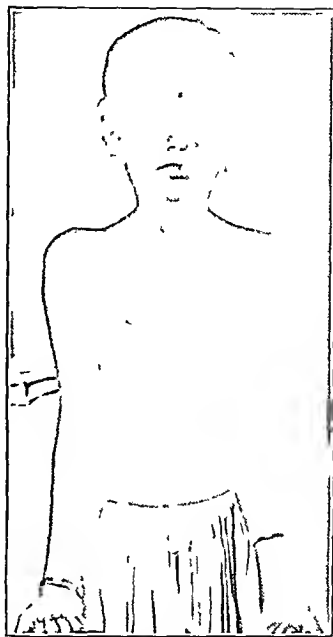


FIG. 2-F

Case 4. June 19, 1938. Photographs show the increased range of flexion and extension after ulnar transposition. Note the slight cubitus valgus deformity.

comes difficult because of the swelling, but when that subsides, it is easy to palpate the displaced fragment under the skin. This is a valuable help during the manipulation of the fragment into position. A perfect diagnosis can be made from the roentgenograms.

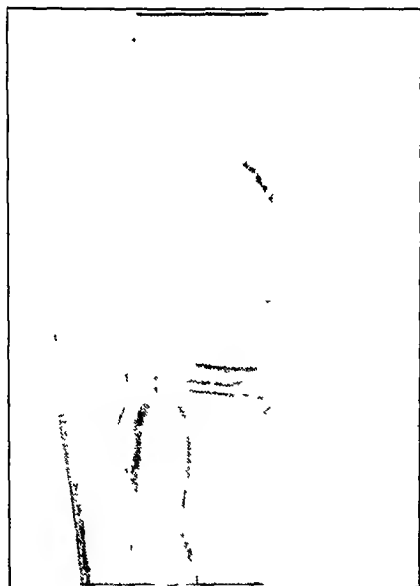


FIG. 3-A

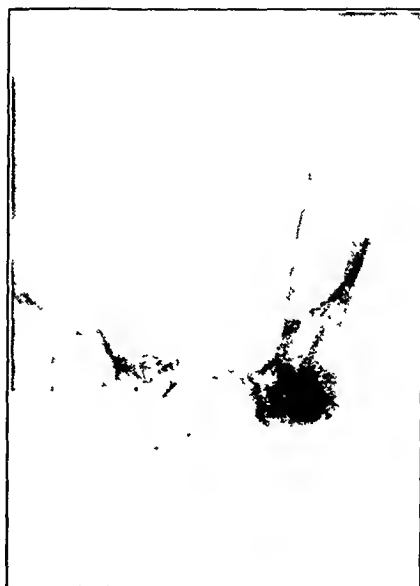


FIG. 3-B

Fig. 3-A: Case 6. October 18, 1938. Capitellar fracture with severe displacement similar to that in Fig. 1-A.

Fig. 3-B: November 19, 1938. Result of reduction by closed method.

TREATMENT

Various views are held with regard to the treatment of this fracture, and the following methods have been advocated:

1. Closed reduction of fragments,—a method of treatment just mentioned in passing.

2. Open reduction and pegging of the fragment to the diaphysis,—universally accepted as the method of choice.

3. Operative removal of the fragment, if it is malunited, or if non-union has occurred which interferes with the movement of the joint.

Wilson⁶ has stated: "A rare case has been reported, in which a rotated fragment was replaced by closed manipulation, but this method fails so uniformly that the author considers it folly even to attempt it."

Though operative fixation is the accepted treatment, the object of this paper is to show that closed reduction has a definite place in the treatment of this condition.

Every case in this series was associated with a large effusion, and the first step was to reduce the swelling by putting the limb in extension in a Thomas arm splint with a firm bandage around the elbow, not interfering with circulation. The subsidence of the swelling occurred

in two or three days after rest in extension, and the displaced fragment could be easily palpated under the skin.

Under an anaesthetic the extended limb is slowly flexed to a right angle, maintaining extension and counterextension at the elbow, with the thumb giving a steady upward pressure against the upper end of the lower fragment, which is pointing downward because of the displacement. This manoeuvre has a double effect. The extension and counterextension disengages the lower fragment and prevents its hitching against the diaphyseal lower end of the humerus; and the steady upward pressure guides it toward the lower end of the upper fragment. At the same time the flexion at the elbow is increased with marked pronation of the forearm. Sometimes it is necessary to abduct the forearm slightly in supination and press down the upward tilt of the



FIG. 4-A

Case 13. October 23, 1939. Capitellar fracture with marked displacement of the fragment.



FIG. 4-B

Case 13. October 23, 1939. Roentgenogram taken after reduction, with the cast in place.

fragment. A definite click at this stage indicates the reduction of the fragment and the movements become freer at the elbow. On no account should the movements be tried over a longer range, especially in supination.

When it is felt that the reduction is complete, a plaster strip four inches wide is applied gently to the skin (enclosing the posterior segment of the circumference and lower two thirds of the upper arm, including the flexed elbow), is molded to the shape of the posterior aspect of the arm and over the supracondylar ridge, and is allowed to set. Next a similar strip is applied from the posterior aspect of the lower two thirds of the upper arm to the proximal part of the wrist. This plaster strip covers the posterior aspect of the lower two thirds of the arm and the forearm on either side of the ulnar border. A cotton pad about one inch in thickness is cut to the required size, is put in front of the elbow, and extends from the lower two thirds of the upper arm to two inches below the crease of the elbow. A strip six inches wide, extending from the upper arm to the limits of the pad below the elbow crease, is laid in front of the elbow, gently



FIG. 4-C

Case 13. October 25, 1939. Clinical photograph with the plaster splint applied.

molded, and allowed to set. Another strip four inches wide is laid in front of the forearm—with the wrist in dorsiflexion to relax the extensors of the wrist—and ends in the palm just proximal to the proximal crease. A circular plaster bandage is then applied to strengthen the plaster (Fig. 4-C).

It must be definitely ascertained before the application of the plaster that there has been no primary nerve lesion; and after reduction of the fragment and flexion of the elbow the radial pulse must be quite palpable. The patient is advised to report the next day for a roentgenogram of the elbow, and the limb is examined carefully for any complications which may arise.

If the fragments have been reduced properly, the plaster is removed at the end of three weeks, and the elbow kept in flexion in cuff and collar. At the end of the fourth week, if the fragments are found to be firmly united, active movements and gentle massage are begun. No passive movements are ever permitted in the region of the elbow, and it is better if, in the beginning, these active movements are made under the direction of the surgeon. It must be made clear to the patient's parents that extension at the elbow will come with time, but flexion is the movement that has to be conserved. The rule which applies to the after-treatment of all elbow injuries, in connection with the restoration of function, is "to make haste slowly". Aided and resisted exercises are permitted, to improve the weight-bearing capacity, when the surgeon is convinced of the firm union of the fragments.

COMPLICATIONS

Malunion and Non-Union

There were four cases of malunion, the most common complication, and one case of non-union. The result of malunion was an exaggerated cubitus valgus deformity in three cases, and cubitus varus deformity in one. In the three patients with cubitus valgus deformity, there was limitation in flexion and extension with definite impairment of function. In one, as a result of forced movements done outside to restore function, marked new bone formation developed simulating clinically myositis ossificans (Case 12). In this case the limitation of flexion and extension was remarkable. The patient was treated by manipulation under anaesthesia; the elbow was placed in acute flexion and subsequent plaster casing to give it rest. After four weeks the plaster was removed, the elbow was supported by cuff and collar, and active movements and massage were instituted. The boy has regained a useful elbow. In the other two cases flexion was more limited than extension. In the case of cubitus varus deformity in a girl of seven (Case 7), the flexion and extension were within the functional range of the elbow, so no surgical interference was advocated, though the aesthetic appearance of the elbow was not satisfactory.

Involvement of Nerves

As a result of cubitus valgus deformity, which often results after this fracture, the ulnar nerve was found to be involved in two cases (Cases 3 and 4). The cause of the limitation of movement at the elbow was brought home accidentally to the author from the experience gained in Case 4. In this case perfect reduction was obtained (Figs. 2-A, 2-B, 2-C, and 2-D), and at the time of discharge a very good functional result was noted. The patient was again brought to the clinic by the mother who stated that the range of flexion had not improved. On examination it was found that in addition to the failure of improvement in flexion, the patient had developed a trophic ulcer on the tip of the little finger with loss of sensation over that finger. The mother was more concerned with the limitation of flexion than with the ulcer as it was painless. To save the nerve, ulnar transposition was done, and it was found after the operation that the range of flexion improved along with recovery of sensation in the area supplied by the ulnar nerve (Figs. 2-E and 2-F). This instance helped the author to understand the limitation of flexion in such cases. It was probably brought about by the protective spasm of the triceps and flexors to prevent the overstretching of the ulnar nerve in acute flexion.

The other patient (Case 3) had a late involvement of the ulnar nerve associated with non-union of the fragment. The accident had occurred when the patient was a child of seven, and weakness of the palm had existed for three years before admission to the Hospital. The patient had typical ulnar paralysis; transposition of the ulnar nerve was advised, but refused, and he was invalided out of the service.

Case 10 was treated by ulnar transposition with marked improvement in the movements of the elbow.

Deformity

A slight cubitus valgus deformity develops even in cases where roentgenographically the fragments appear well set. This is not a great inconvenience, but the patient should be warned that if tingling or loss of sensation develops over the little finger, he should seek surgical advice, with a view to having the ulnar nerve transposed to prevent ulnar neuritis and ulnar paralysis.

CONCLUSIONS

1. Fractures of the lateral condyle in children are known as capitellar fractures, and, when they occur above the origin of the extensors, are accompanied by marked displacement of the lower fragment, causing it to turn over.

2. Closed reduction has given satisfactory results in those patients who sought advice soon after the accident. The main principles are reduction of the effusion, and then the manipulation of the lower fragment into position with the elbow in flexion and the forearm in pronation. If

the forearm is supinated it is found that the gap between the fragments after reduction becomes greater.

3. In the cases which were not treated properly, malunion caused limitation of movements at the elbow. In two cases ulnar transposition improved the functional movement of the elbow; and in one case, with marked new bone formation, rest in flexion improved the functional movement.

4. A slight exaggeration of cubitus valgus deformity has been the rule even in cases with a good roentgenographic apposition and union of the fragments.

The author wishes to thank Dr. P. Kesavaswami, L.M.S., the Roentgenologist, and Dr. T. Mathew, M.B., of the Department of Anatomy, who helped in the experiments on the cadaver.

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HISTOPLASMOSIS OF THE KNEE

BY J. ALBERT KEY, M.D., AND ALFRED M. LARGE, M.D.,
ST. LOUIS, MISSOURI

From the Department of Surgery of the Washington University School of Medicine, St. Louis

Histoplasmosis or reticulo-endothelial cytomycosis is a generalized disease which varies widely in its clinical characteristics, and is caused by the histoplasma capsulatum of Darling. This organism was discovered by Darling in 1906 while he was searching for evidence of kala-azar in smears from the spleen, liver, and bone marrow of all patients showing splenomegaly, who came to autopsy at the Ancon Hospital. Darling noted the similarity of the organism to the Leishman-Donovan body of kala-azar, but pointed out that it differed from this in the form and arrangement of the chromatin of the nucleus, and in that it did not possess a blepharoplast.

Meleney, in a review of the subject, notes that no further cases were recorded until 1925 when a case was discovered in Minnesota; in his paper he reviews the nineteen cases in the literature, and adds thirteen new cases. He states that while the disease is rarely diagnosed, it is probable that it is considerably more frequent than is supposed, that it is widely distributed throughout the world, and that it will undoubtedly be recognized with increasing frequency in the future. He finds that the disease may present one of the four following clinical pictures:

1. A systemic febrile disease similar to kala-azar, with an enlarged liver and spleen, septic temperature, anaemia, and leukopenia;
2. Lymph-node enlargement may predominate, simulating Hodgkin's disease, leukaemia, lymphosarcoma, or aplastic anaemia;
3. Pulmonary symptoms may predominate. The infection is often complicated by, or superimposed upon, pulmonary or generalized tuberculosis;
4. The infection may begin as a small skin lesion which may sometimes develop into a generalized ulcerative skin condition.

The organism as found in the tissues is round or oval in shape and measures from one to four micra in diameter. It has a deeply staining, basophilic central mass or chromatin nucleus which may be round, ovoid, or semilunar in shape. This is surrounded by a clear space, which in turn is surrounded by a refractile achromatic rim. This is the yeastlike form of the fungus.

Darling believed that it was a protozoan parasite. DeMonbreun has cultured the fungus from a patient dying of the disease, and has reproduced the disease in susceptible animals (monkeys). He has also grown the organism on artificial media, and has described and pictured both the yeastlike form which occurs in the tissues, and the vegetable form which

occurs on culture media, and has traced the transformation of the yeastlike fungus to the mycelian form.

In so far as the authors have been able to determine, none of the cases in the literature presented any involvement of the joints or muscles. Recently one of the authors has had under his care a patient from whom the sections from the specimen of the knee joint showed the typical histoplasma capsulatum of Darling. The case is being reported because it is believed to be the first instance in which the disease has been known to involve a joint, and also because the case closely resembled tuberculosis of the knee joint, and was so diagnosed until it was found that the guinea-pig inoculation and the tuberculin test on the patient were negative. It was then thought to be a low-grade infection of unknown origin. The limb was amputated and the correct diagnosis was arrived at only when it was made by Dr. Robert A. Moore of the Department of Pathology, to whom the slides from the tissues were submitted. The case report is as follows:

W. A. S. (Barnes Hospital History No. 89485), a white male, aged forty-seven years, was admitted to the Medical Ward on May 14, 1941, with a history of aching pain and disability in the left knee of seven months' duration. The past history was unimportant. The personal history revealed that the patient had been born in southeastern Missouri, and had lived there on a farm all of his life. He had stopped school at the age of nineteen

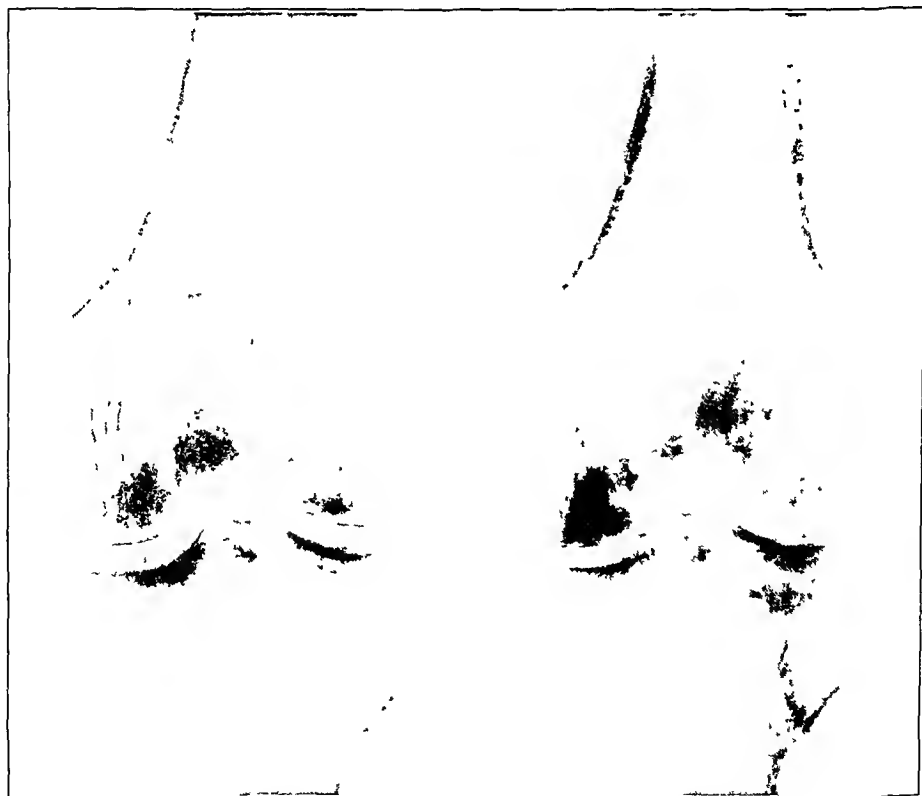


FIG. 1-A

FIG. 1-B

Histoplasmosis of the knee.

May 5, 1941

June 24, 1941

years, at which time he was in the fifth grade. He had never been strong, but had done some light work on the farm. The pain in the knee developed gradually, and was not preceded by any definite injury. The knee became swollen and stiff. The pain increased and was aggravated by movement. It was described as dull and constant in character, except with movement, when it became more intense. He had tried various forms of liniment and local heat, and had had some osteopathic manipulations which seemed to make the knee worse.

At the first admission the patient was walking, but with a marked limp and with considerable pain. On physical examination the temperature was 38.5 degrees centigrade, the pulse was 80, respiration was 22, and the blood pressure was 120/76. The patient was a small, poorly nourished white male who looked older than his stated age. Examination of the skin revealed a large number of papillomata over the body, and especially over the face, neck, and thorax. The clinical diagnosis was neurofibromatosis, which was subsequently confirmed by biopsy of the papillomata. Other than the neurofibromatosis and the arthritis of the left knee, the general examination was negative.

The left knee was held in a position of moderate flexion, and the patient objected to its being moved, only a few degrees of movement being permitted because of pain and muscle spasm. On inspection the knee was considerably enlarged, being about half again as large as the other knee. The enlargement was symmetrical, the synovial cavity was distended, and the knee joint contained excess fluid. Also, the periarticular tissues were thickened. There was moderate increase in local heat over the knee joint, and on deep pressure it was moderately tender. There was no redness. The medical diagnosis was (1) infectious arthritis; (2) neurofibromatosis; and (3) mental deficiency.

Roentgenograms of the left knee and chest were taken. The lateral view of the knee joint showed thickening of the soft tissues and moderate bone atrophy with spotty atrophy of the bone structure. The anteroposterior view showed spotty atrophy and no



FIG. 2-A

FIG. 2-B

Histoplasmosis of the knee.

May 5, 1941

June 24, 1941

decrease in the joint space, and in neither view was there any evidence of new bone formation. The chest film showed rather well-defined rounded areas of almost complete opacity measuring seven by seven centimeters in the lower half of each lung field between the fourth and sixth ribs anteriorly. Although these areas had an appearance suggestive of encapsulated interlobar collections of fluid, roentgenographic diagnosis was deferred.

Laboratory findings showed:

Red blood cells—4,890,000

White blood cells—12,250

Segmented polymorphonuclear neutrophils—79 per cent.

Non-segmented polymorphonuclear neutrophils—6 per cent.

Polymorphonuclear basophils—1 per cent.

Lymphocytes—11 per cent.

Mononucleurs—3 per cent.

Kahn test—negative

Gonococcus fixation test—negative

Urinalysis—normal

The patient remained in the Hospital and was treated with sulfathiazole on the basis that possibly this was pyogenic arthritis. He was given one gram of the drug every four hours for six days. However, during this period there was no improvement in the knee, and the temperature ranged between 37.5 and 38.5 degrees centigrade. He was then seen in consultation by one of the authors, who made a tentative diagnosis of tuberculosis of the left knee. The knee was aspirated and the fluid, which was thick purulent material, was cultured and was inoculated into a guinea pig. At this time the patient refused surgery or immobilization of the knee, and he went home on May 29, 1941. The culture of the pus was sterile. The guinea pig subsequently was killed and showed no evidence of tuberculosis.

The patient returned to the Hospital on June 23, 1941, on the Orthopaedic Service, and stated that his knee had become increasingly painful and stiff, and that he wanted the leg amputated.

At this time the patient was not able to walk or bear weight on the extremity. On physical examination the knee was markedly swollen, very tense, moderately tender, and exquisitely painful on movement. The local temperature of the skin over the joint was moderately elevated. Not only was the entire region of the knee joint swollen, but there was considerable swelling of the calf, which too was tense, tender, and fluctuant. The white-blood-cell count was 16,400, and the red-blood-cell count was 3,636,000. New roentgenograms showed increased density of the synovial tissues, increased atrophy of the bone, some narrowing of the joint space, and marked broadening and erosion of the margins of the intercondylar notch.

The joint was aspirated, and about ten cubic centimeters of very thick, white purulent material was withdrawn. The pus was so thick that great difficulty was encountered in withdrawing it, even with an 18-gauge needle. The leg was immobilized on a splint, and the patient was put on a high caloric diet in an effort to build him up for operation.

At this time, it was felt that this was probably a low-grade pyogenic infection, or possibly a fulminating tuberculosis of the knee, since the culture of the pus was again negative. It was believed that the amount of destruction which had occurred over the four-week period was too great to be explained by an ordinary tuberculous infection. (The negative report from the guinea-pig inoculation at the previous admission had not yet been obtained.) After talking the matter over with the patient's family, it was concluded that the extremity should be amputated. An amputation through the middle and lower thirds of the thigh was performed on June 28, 1941; sulfathiazole powder was placed in the wound; it was closed without drainage; and traction was applied to the stump. The patient was quite comfortable after the operation, and the wound healed by primary intention.

The sutures were removed on the seventh postoperative day. Two days later the patient became stuporous and cyanotic, and the neck became rigid; he developed ankle

clonus, and was obviously quite sick. Examination of the chest showed dullness to percussion, increased breath sound, and myriads of fine râles over the lower lobe of the right lung. The peripheral veins were quite distended. The patient was seen by Dr. Leo Gottlieb who made a diagnosis of right-lower-lobe pneumonia, complicated by right heart failure and meningismus. Lumbar puncture was negative, with the exception of a moderate increase in the protein in the spinal fluid. He was placed in an oxygen tent and was given sodium sulfathiazole intravenously. He died on the following day. Autopsy was refused, and the true diagnosis was not suspected until the microscopic sections of the synovial tissues of the knee were examined.

Pathological Findings

On gross examination of the specimen, the knee was found to be considerably enlarged. The synovial cavity was converted into a large abscess cavity which was filled with thick gray purulent material; the abscess extended into the calf of the leg. The articular surfaces of the bones showed considerable erosion and necrosis, and, grossly, the specimen resembled advanced tuberculosis of the knee. The synovial tissues were markedly thickened and covered with a grayish-white exudate.

Microscopic Examination

Sections from three areas of the joint were studied: (1) the fibrous tissue of the synovial membrane; (2) the cellular layer of the synovial surface; and (3) the cortex of the femur beneath the synovial surface. Examination of these sections revealed the following:

1. The fibrous portion of the synovial surface showed relatively little reaction, and



FIG. 3

Roentgenogram showing chest of the patient with histoplasmosis. It is believed that the opaque areas in each lower lobe are due to the infection. At this time no physical signs were detected.

the dense fibrous tissue was, as a rule, not invaded by the inflammatory process, although a few monocytes which contained one or two organisms were seen beneath the surface, and there was a slight amount of proliferation of the surface cells.

2. The cellular portion of the synovial surface was markedly thickened, and was composed of a mass of mononuclear cells embedded in a youthful connective-tissue



FIG. 4-A ($\times 165$)

Photomicrographs of synovial tissue. (See also Figs. 4-B, 4-C, and 4-D.) Note giant cells, the nuclei of which are, for the most part, not visible. The histoplasma capsulatum of Darling are the small clear spherules, with the deeply staining body or nuclei, which are seen within the bodies of the giant cells.

network. The blood vessels were moderately increased in size and number. The synovial membrane was transformed into a mass of granulation tissue, which was intensely infiltrated with macrophages and giant cells, and was characterized by the presence of numerous areas of focal necrosis which resembled the caseation found in tuberculosis. In these areas there were degenerating cells and numerous giant cells, some of which also were degenerating. The great majority of the cells in the inflammatory exudate were mononuclear phagocytes or monocytes. Many of the phagocytic cells contained minute spherical bodies which varied in size from three to five micra in diameter. These bodies possessed a clear cytoplasm which was surrounded by a refractile ring and contained a

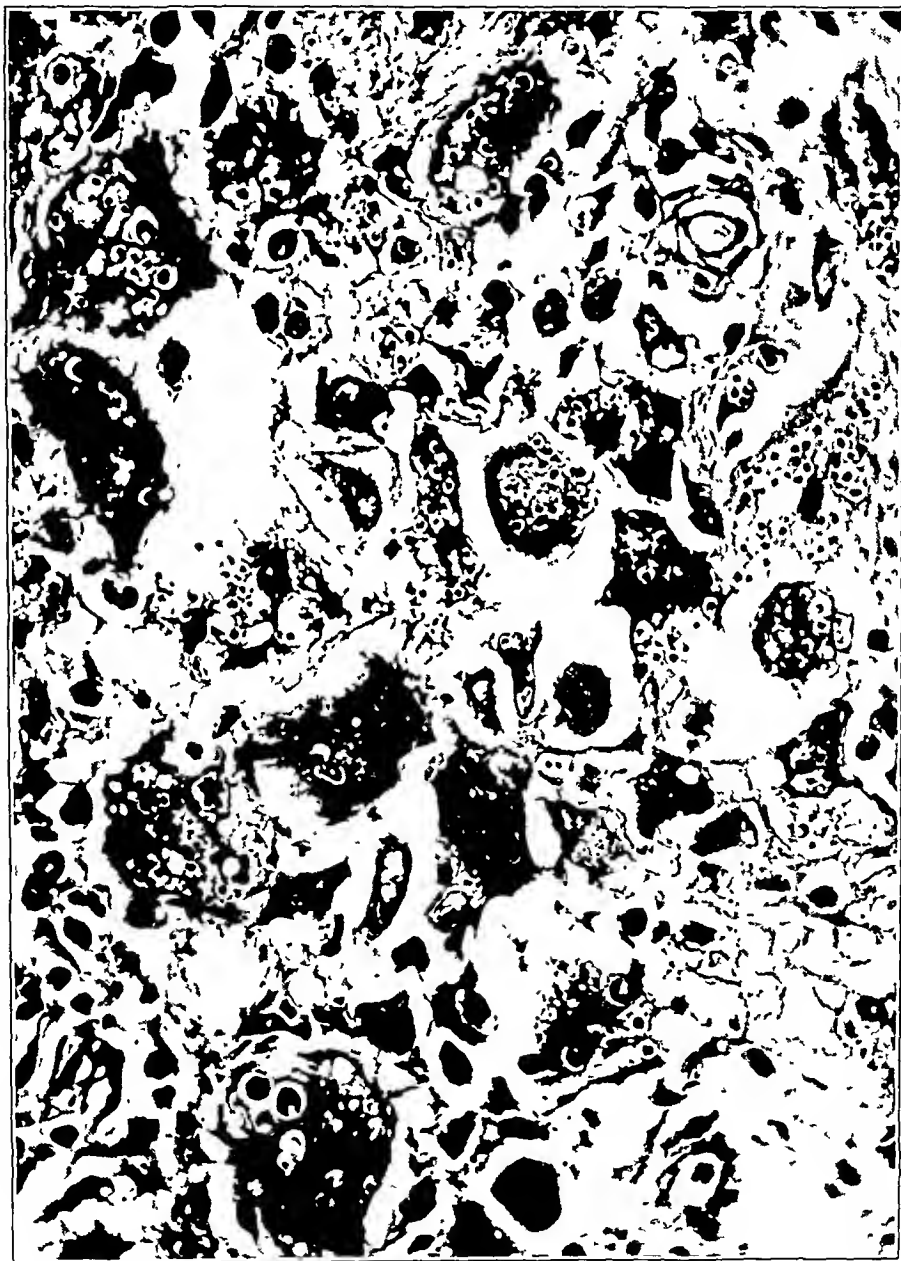


FIG. 4-B ($\times 650$)

deeply staining central mass or nucleus which was usually spherical, but might be irregularly ovoid or semilunar in shape, and was about one-half the diameter of the parasite. These were the histoplasma capsulatum of Darling. In some areas the parasites were present in enormous numbers, and crowded the bodies of the large macrophages and giant cells. Where these cells were burst or degenerating, the parasites were free in the tissues or in the necrotic debris, but for the most part they lay in the cells. Relatively few of the monocytes contained any other phagocytized material, and very few of them contained red-blood cells. The endothelial cells or monocytes merged into the phagocytes, and these, in turn, merged into the giant cells which varied greatly in size; some of them

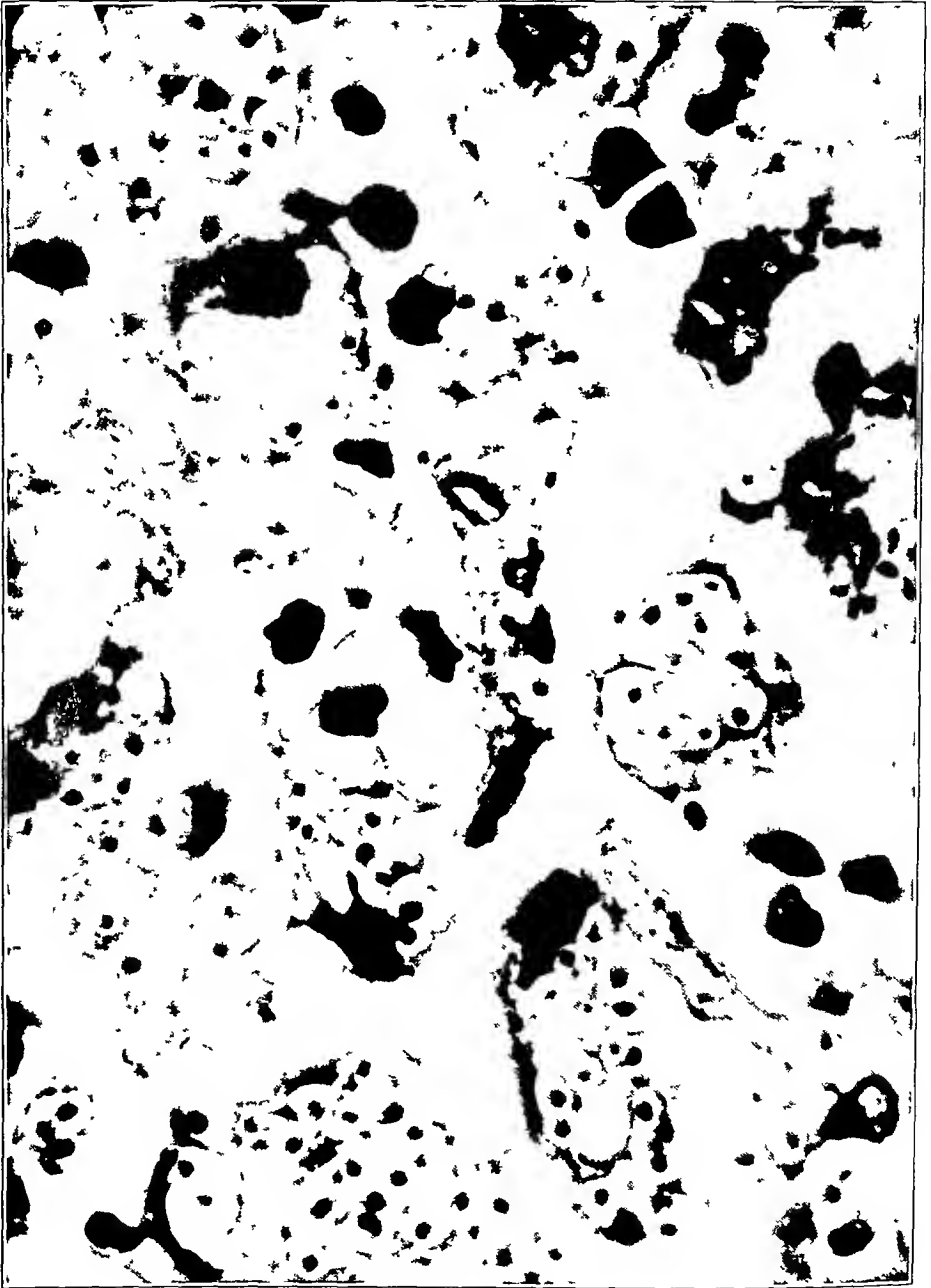


FIG. 4-C ($\times 1380$)

contained fifty or more nuclei and resembled foreign-body giant cells. There was a striking absence of polymorphonuclear leukocytes in the diseased areas of the tissue.

The pathological picture resembled that of a tuberculous synovial membrane, except that there were no tubercles and the giant cells were of the foreign-body type. When the sections were stained for acid-fast bacilli, no organisms were seen.

The synovial surface was covered with an exudate which contained many well-preserved cells, mostly mononuclear phagocytes and small round cells (probably lymphocytes and plasma cells). It also contained a considerable number of giant cells, some of which were quite large, exhibiting thirty-five or more nuclei in a single five-micron sec-

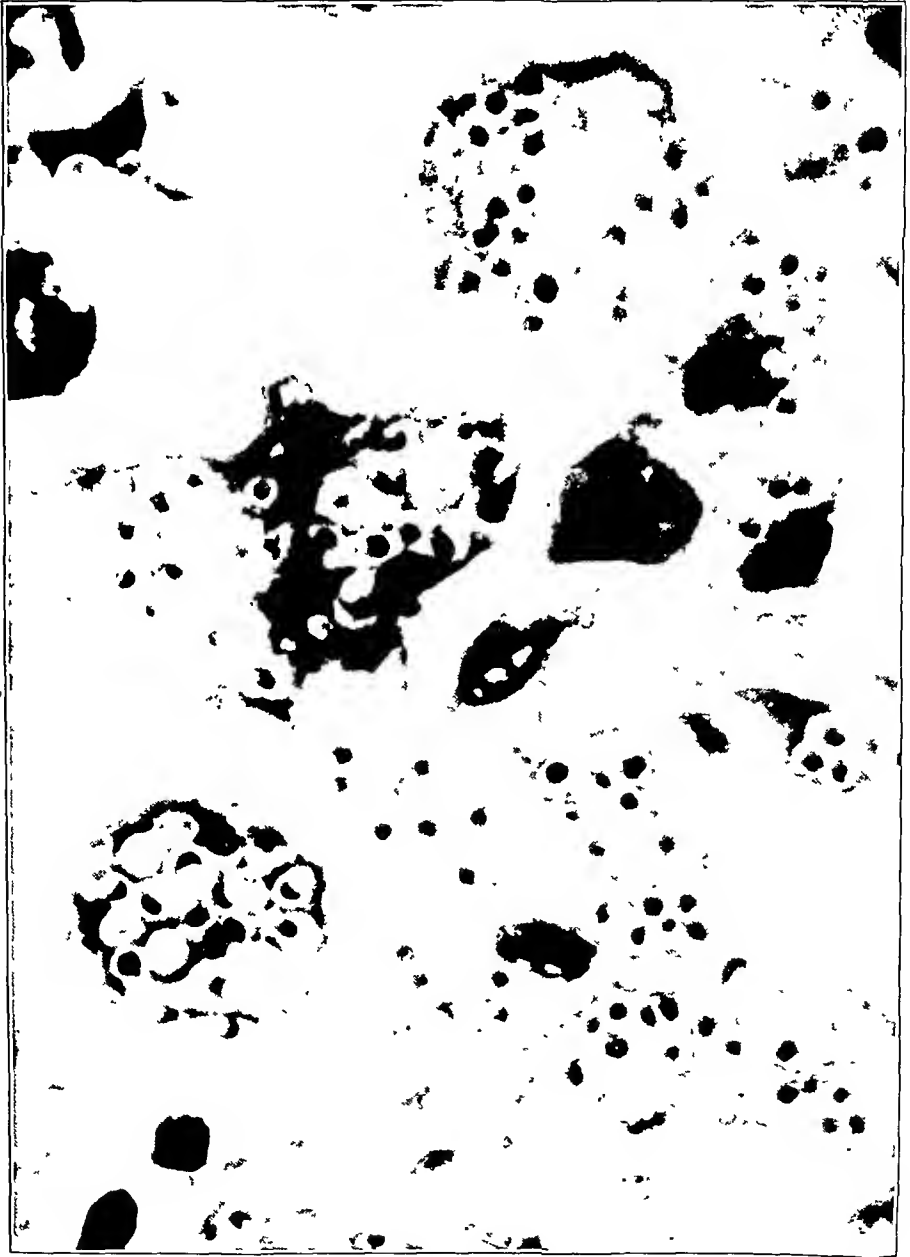


FIG. 4-D ($\times 1730$)

tion. In some areas the exudate was composed of a mass of fibrin and of necrotic cells. In the bodies of the mononuclear phagocytes and of the giant cells in the exudate, there were large numbers of the yeastlike organisms. Some of these organisms were free in the coagulated exudate, but, for the most part, they were intracellular.

3. The invasion of the bone was also similar to that which occurs in tuberculosis. The infected inflammatory tissue extended down through the nutrient canals of the cortex and spread out in the bone-marrow spaces. The trabeculae in the bone marrow tended to be eroded by the granulation tissue, and showed little or no tendency to the production of new bone. Likewise, the bone was not killed by the juxtaposition of the infected granulation tissue. Outside of the areas where the bone marrow had been invaded through the nutrient canals, the cancellous bone and marrow appeared to be normal and no organisms were found in this tissue. They were, however, quite numerous in the cells of the granulation tissue which had invaded the bone marrow, but were not so numerous as they were in the inflammatory tissue of the cellular portion of the synovial surface.

DISCUSSION

In looking back over this case, the appearance of the lesions in the lungs, which were probably caused by the fungus (Figs. 4-A, 4-B, 4-C and 4-D), and the course of the disease in the knee, and physical and laboratory findings should have led to the suspicion of a fungus infection instead of, first, tuberculosis, and later, a low-grade pyogenic infection in the knee. Naturally, the authors are not proud of their record, but feel that this case should be recorded because, if Meleney's predictions come true, other cases will appear, and it is probable that other clinicians will make similar mistakes.

However, even had an early diagnosis been arrived at, it is probable that the fatal outcome of the disease could not have been avoided, because, with two exceptions, in all of the cases recorded in the literature, the patients have died of the disease. Meleney believes that antimony preparations may offer hope of cure. His paper should be consulted by those wishing to learn more of the disease. It is to be noted that in this patient the administration of full doses of sulfathiazole had no beneficial effect.

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TREATMENT OF CONGENITAL TALIPES EQUINOVARUS WITH A MODIFICATION OF THE DENIS BROWNE METHOD AND SPLINT *

BY STUART A. THOMSON, M.D., TORONTO, ONTARIO, CANADA

From the Hospital for Sick Children, Toronto

A wide provincial practice is enjoyed at our weekly Club-Foot Clinic, so that no fewer than twenty-five to thirty new cases are seen each year, with an average of ten patients each week.

Until two and a half years ago manipulation and plaster was the method of treatment. This was done without anaesthesia at intervals of two to three weeks and finally the equinus was corrected by a subcutaneous tenotomy under anaesthesia. A club-foot splint was then provided, and the parent was instructed to carry out daily stretching.

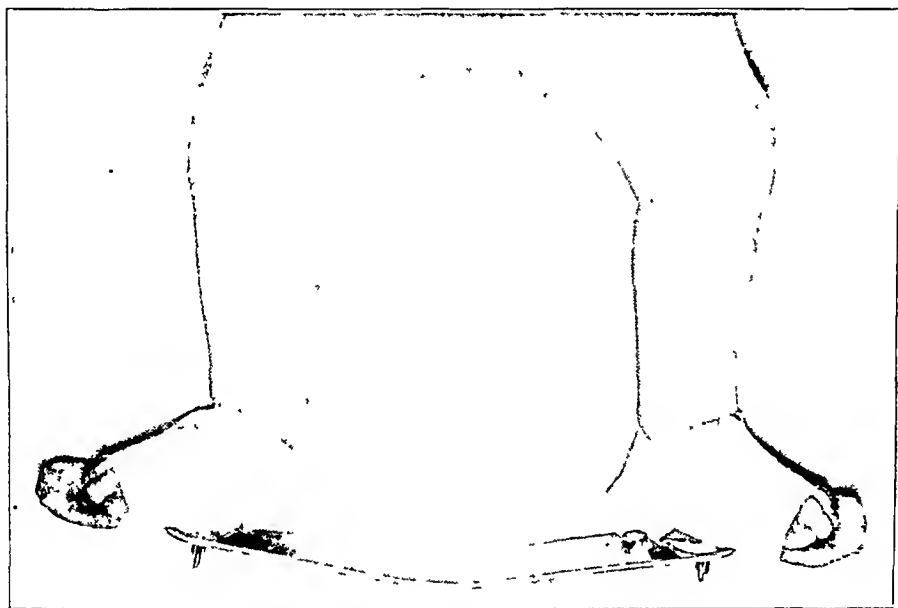


FIG. 1

A discouraging rate of recurrence persisted with this method. The difficult problem that a recurrent club foot presents need not be elaborated upon except to say that eventually many of them require an arthrodesis at an undesirably early age.

Two and a half years ago the author was attracted by the simplicity of the Denis Browne method ¹ and since its application the results have been most gratifying. Sixty new cases of the equinovarus variety have

* Presented at the Clinical Session of the Annual Meeting of The American Orthopaedic Association, Toronto, June 9, 1941. Received for publication July 30, 1941.

been treated, and only one definite recurrence has been discovered. The blame for this is entirely credited to the mother, who abandoned all care of the feet for over two months. This occurred during the third phase of the treatment,—namely, the stage of boot splints.

The author prefers to start treatment during the first month of life, usually at about three weeks of age. The oldest untreated patient was one year of age and the child responded just as rapidly with a most satisfactory correction.

The principle of treatment for the correction of deformity is to strap the feet to the splint, which has a connecting cross bar, and then let the infant correct its deformity by incessant kicking (Fig. 1).

For the sake of convenience, the treatment is divided into four phases (assuming that it is started during the first few weeks of life):

(1) The phase during which the deformity is corrected and carried into over-correction (usually five to six weeks' duration).

(2) The phase of maintaining the correction in the same adhesive splints (approximately five months or even less, if the feet are large enough).

(3) A further period of maintaining correction by the use of boot splints (about six months' duration or until walking commences).

(4) The period during which the boot splints are used as night and resting splints, and supplemented with special walking boots during the active periods of the day. The duration of this phase will have to be decided upon in the future, but should be carried on for at least two to three years. It will depend upon the cooperation of the parents and the diligent observation of the doctor. It is suspected that most recurrences will appear in this phase, as it has done so notoriously with former methods of treatment.

The splints which are used for correcting the deformity are made in three standard sizes (Figs. 2 and 3), the largest being used for old recurrent cases. Duralumin, one-sixteenth of an inch thick, is used for the two larger sizes, and aluminum, one thirty-second of an inch thick, for the smallest size. There is an upright projection on the outer side which

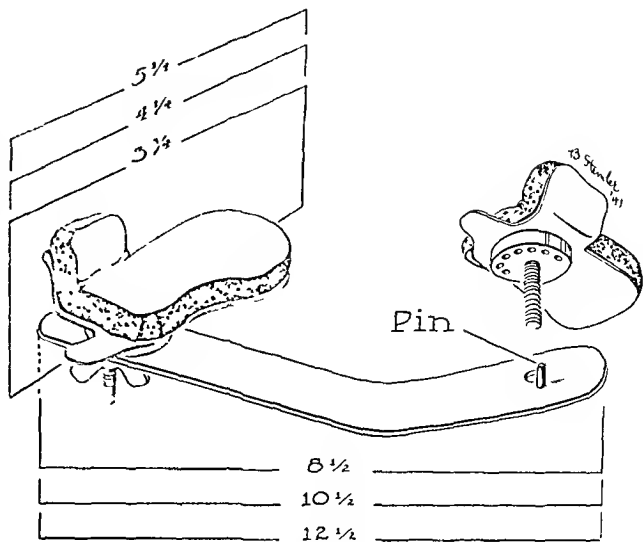


FIG. 4

Modification of Denis Browne splint for club feet.

reaches the upper limit of the malleolus. An important feature is the posterior narrow projection for anchoring the adhesive and so keeping the heel down in place. The splint is covered with sponge rubber. On the under side is a bolt (Fig. 3), with a circular metal washer at its base which contains a series of holes. A pin in

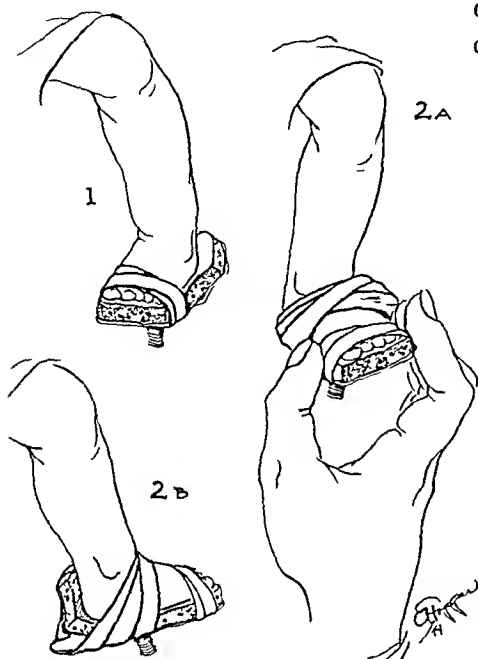


FIG. 5

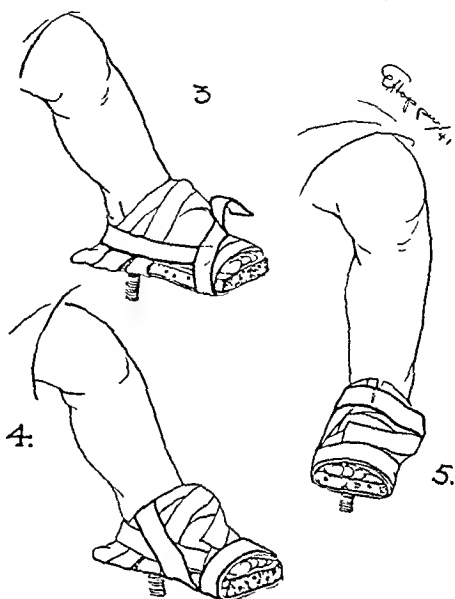


FIG. 6

An effective method of taping the foot in the Denis Browne splint.

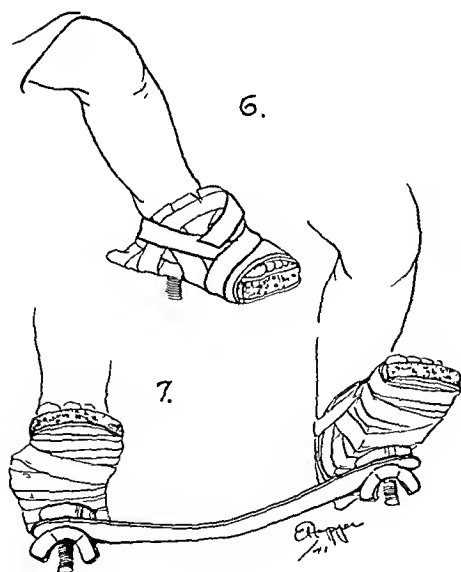


FIG. 7

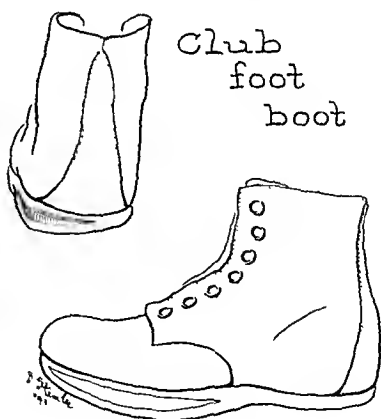


FIG. 8

Club-foot boot.

the cross bar fits into the desired hole, making the position secure and easily recorded from week to week.

When treatment is started at an early age (three to four weeks), weekly visits are required for the first four to six weeks and then every two weeks thereafter. At each sitting the foot is restrapped, without

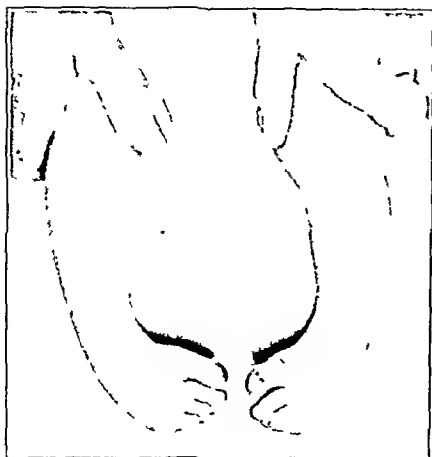


FIG. 9-A

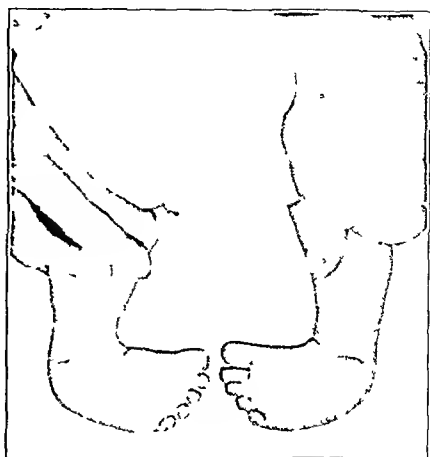


FIG. 9-B

December 24, 1940. R. M., aged three weeks. Anterior and posterior views before treatment.



FIG. 9-C

December 3, 1941. R. M. Photograph demonstrates the normal degree of overcorrection.

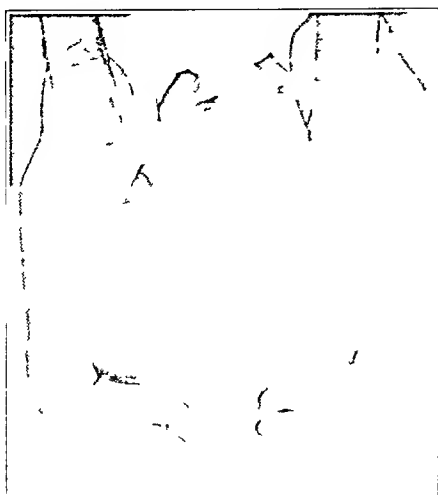


FIG. 10-A

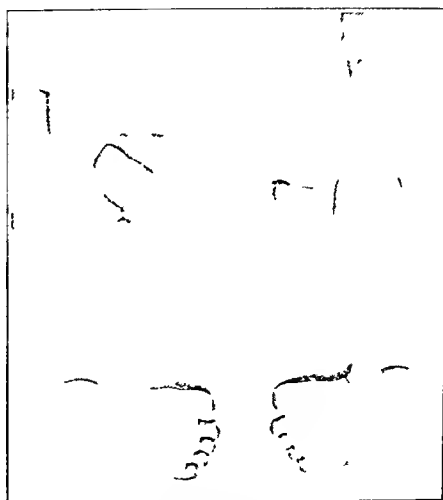


FIG. 10-B

April 16, 1941 A P, aged four weeks. Anterior and posterior views before treatment.

any manipulation whatsoever being done. Soft-backed adhesive tape is used, and the selection of suitable widths is most important, especially for those passing across the front of the ankle (Figs. 5, 6, and 7). The position of the foot piece on the cross bar is then adjusted so as to increase the degree of abduction. If it is a case of unilateral club-foot, the normal foot is kept in an anteroposterior attitude.

It thus becomes evident that the adduction deformity is corrected by adjusting the splint each week into a further degree of abduction. The varus deformity starts its correction when the foot reaches the anteroposterior plane. In this position, when one leg is extended and the other flexed, the foot on the flexed side is forced into valgus. The equinus deformity reaches its maximum period of correction when the foot has been abducted to a right angle on the cross bar. When the child flexes the side with the abducted foot, it is forced into dorsiflexion. During an infant's waking moments, these movements with all their combinations are repeated hundreds of times. The degree and speed of correcting the varus and equinus can be increased by bending the cross bar away from the child (Fig. 4).

The foot is usually completely overcorrected at the end of six to seven weeks. During the second phase the splinting is continued in a position just short of full correction (right angle) until the foot is a reasonable size. This is usually at six to seven months of age.

At no time has any skin irritation or ulceration prevented the continuance of treatment. Anointing the feet with ether or tincture of benzoin compound has been helpful in some cases. Any other type of care—such as washing or rubbing off the epithelial debris—is discouraged. The author has been warned of the possibility of a knock knee but has not seen it occur yet. A cross bar suitable in length for the various age periods has probably prevented this complication.

The third phase of treatment begins at six to seven months of age, when the feet are measured for boot splints (Figs. 2 and 3) which have exactly the same fittings on the sole for adjustment with the cross bar. The boots are open at the toes to allow for growth, and fitted with an ankle strap which ensures the firm position of the heel on the sole.

The parent is then instructed in its use and also in the daily stretching of the foot. The splint is kept on day and night with the foot just short of a right angle. At about one year of age walking lessons are started for short periods each day.

In this fourth phase walking boots are supplied (Fig. 8), which have an outside wedge of three-sixteenths of an inch, and no heel. In this way the heel is kept low and the tendo achillis out to length.

The author is convinced that most of the recurrences are primarily due to a shortening of the tendo achillis, as a result of which the foot takes on an adduction and varus deformity in order to let the heel reach the ground.

The boot splint is now used as a night splint for at least another year.

This method has completely eliminated manipulations, plasters, tenotomies, and anaesthetics. Only half as much time at the Clinic is required.

Several recurrent cases (as a result of former methods of treatment) have been treated by the Denis Browne method with surprisingly good results. The degree of success, however, varies inversely with the age. In other words the older the child, the less is the tendency to struggle and

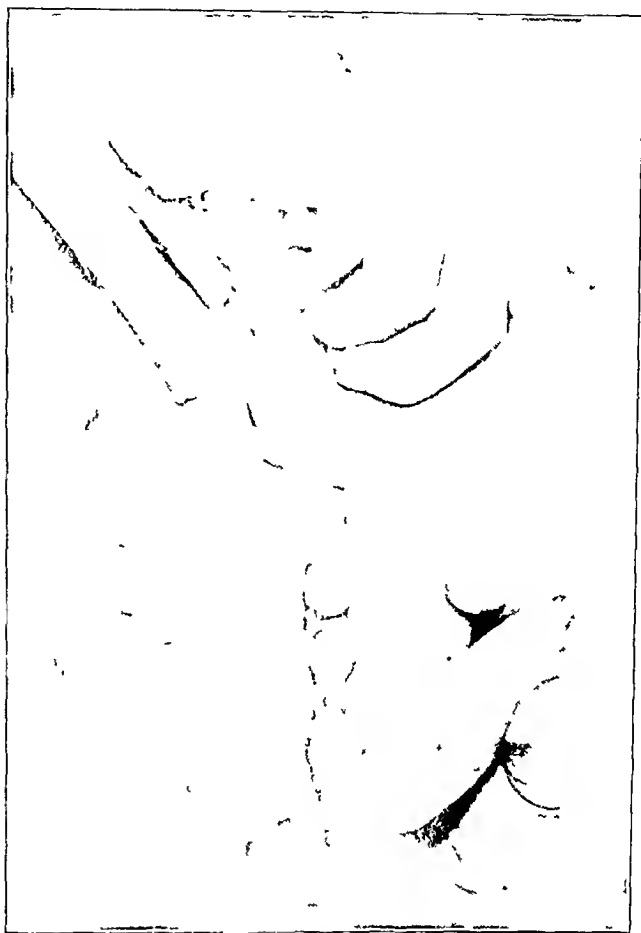


FIG.10-C

November 26, 1941 A P Photograph demonstrates how easily and normally full over direction is obtained.

kick. An upper limit of three years of age is suggested for this method of treatment. The child should be encouraged to crawl, stand, and jump, so as to make up for the ceaseless kicking of the infant.

The author's experience has been rather limited with this method, but he is impressed with the remarkably normal appearance of these feet, the well-developed calves, and the absence of any tibial torsion. During the next few years it will be interesting to see if recurrences appear, as upon that will depend the success of this type of treatment.

The author wishes to thank D. E. Robertson, M.D., and the Surgical Staff for giving him the monopoly of these cases and allowing him to conduct the Clinic.

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THE LUMBOSACRAL REGION

A CORRELATION OF THE ROENTGENOGRAPHIC AND ANATOMICAL OBSERVATIONS

BY HOMER C. PHEASANT, M.D., AND PAUL C. SWENSON, M.D., NEW YORK, N. Y.

From the Departments of Surgery and Radiology of the Presbyterian Hospital and of the College of Physicians and Surgeons, Columbia University, New York

Present-day evidence suggests that the form and number of segments of the human spine are not constant, and that there is an evolutionary trend toward a reduction in the number of thoracolumbar segments and increased stability at the lumbosacral junction. The same factors which are thought to have been instrumental in effecting a reduction in the thoracolumbar segments of certain primates to seventeen or sixteen from the mammalian average of nineteen to twenty segments, are active at this time in man. These factors are: (1) a necessity for increasing vertebral stability brought about by an orthograde position, and (2) the influence of increasing body bulk on the length of the lumbar spine. These factors are interrelated, and their effect is shown by a continued reduction in the number of thoracolumbar segments in those anthropoids in which increased body bulk is combined with the upright posture. Keith¹ describes this shortening of the loin as not only effecting a great economy of muscular effort in the maintenance of the upright position, but also as eliminating some of the dragging strain on the viscera, which a longer loin in the upright position would entail.

CLASSIFICATION

The vertebrae are classified into five groups—cervical, thoracic, lumbar, sacral, and coccygeal—on the basis of certain criteria which include: (1) the plane of the articular processes, (2) the development of accessory transverse processes, (3) the attachments of the ribs, and (4) the shape of the vertebral body.

Because of the aforementioned evolutionary trend, variations in the form and number of segments in each group occur in different individuals.

Variations in form are likely to be found in those segments of one group which are situated adjacent to another. One segment, therefore, may have some characteristics of one group and others of another, with the result that it may be difficult to determine to which group the segment belongs. Such a transitional segment is usually classified on the basis of its predominating characteristics. At the lumbosacral junction, variation in the plane of the articular processes from a sagittal to a coronal direction, together with enlargement ("fish-tailing") of the transverse processes, suggests that such a vertebra has assumed sacral characteristics and should be identified as a transitional sacral vertebra

A change in the number of segments in two groups may occur without altering the total number of segments in the whole spine; the addition of one segment to a group usually occurs at the expense of the adjacent group. The lowest lumbar segment, for example, may be so altered in form that it must be classed as sacral, leaving only four instead of five lumbar elements. Hence one may properly speak of the sacralization, partial or complete, of the lowest lumbar segment.

COMBINED ROENTGENOGRAPHIC AND ANATOMICAL STUDY

The exact anatomical form of the various elements of the lower lumbar spine and the adjacent upper sacral segments is frequently difficult to appreciate from the roentgenographic examination, even with good stereoscopic, anteroposterior, and lateral views. This difficulty led the authors to undertake a combined roentgenographic and anatomical study of the lumbosacral region, with the hope of acquiring a better understanding of certain confusing lines and superimposed shadows on the roentgenograms.

During the past three years anteroposterior, stereoscopic, and lateral projection roentgenograms have been made of the lumbosacral spines of the fresh cadavera received by the Department of Anatomy. These roentgenograms were made before any radio-opaque material had been injected into the vascular system. One hundred and seventy-one cadavera were examined.

The source of material made the average age high, fifty-five and nine-tenths years, and resulted in a preponderance of males. In all cases where interesting anomalies or questions of interpretation arose in the roentgenographic examination, the lumbar vertebrae, sacrum, and ilia were removed, cleaned, and mounted, so that they could be carefully compared with the roentgenograms. Forty-two specimens in all were thus prepared.

The purpose of this paper is to present the results of this correlation of shadows on the roentgenogram with the actual anatomical arrangement and form of the segments in the dried specimen.

It was considered of value to make observations on the following points, the details of which are discussed in the text:

1. Architectural variations.

- (a) In the plane of the lumbar articulations;
- (b) In the transverse processes of the last lumbar vertebra;
- (c) In the fifth lumbar segment as a unit.

2. Incidence of congenital anomalies.

- (a) Bifid neural arch;
- (b) Separate neural arches;
- (c) Separate ossicles.

3. An estimation of the degree of osteo-arthritis shown in the roentgenogram for a comparison later with the actual amount present in the dried specimen. A correlation could then be made with the incidence of

variations in the plane of the articular facets as well as with the sacral inclination.

ASYMMETRICAL ARTICULATIONS

The tendency in man for the lumbosacral articulations to lie most frequently in an oblique or coronal plane would indicate that stability, rather than flexibility, is the deciding factor in the position they assume. In man, flexion and extension of the lumbar vertebrae do not have the same functional significance which they do in quadrupeds. Variations in these articulations occur because the vertebral form of man is not stable and because there is a continued evolutionary influence, reflected particularly in variations of configuration in the last lumbar vertebra. Asymmetry in the plane of the facet surfaces is seen in the anthropoids, but is more frequent in man. Because of man's constant upright posture and forwardly inclined sacrum, structural variations at the lumbosacral joint are of particular significance, since this may result in alteration of

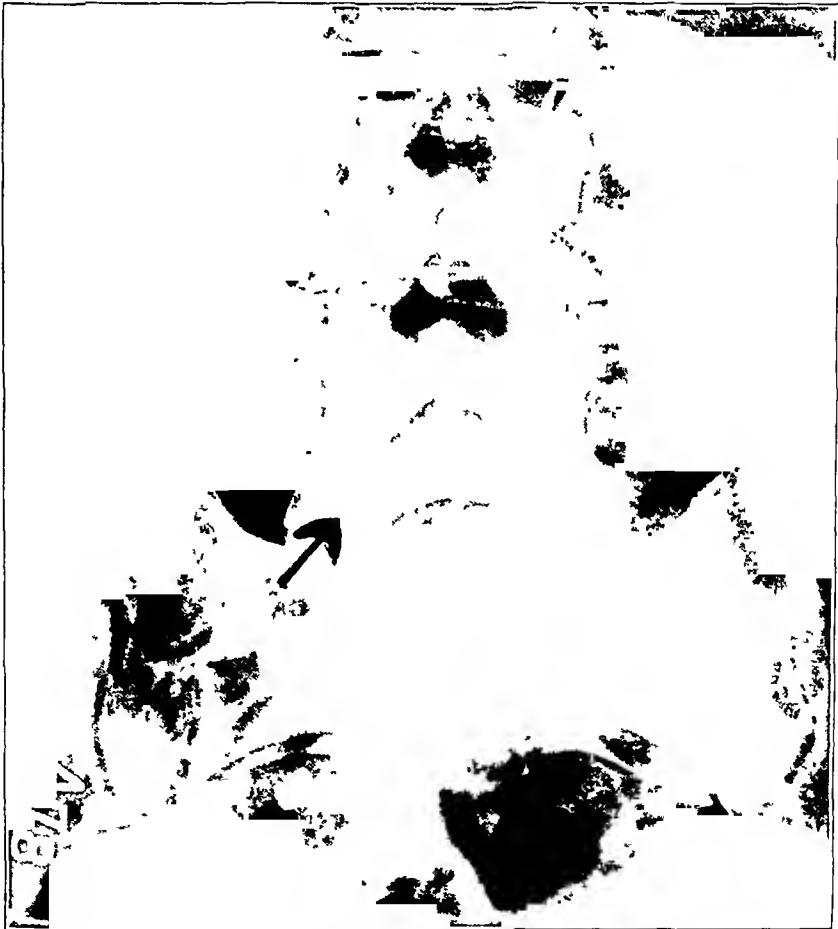


FIG. 1

Roentgenogram with arrow indicating an area suggesting a fusion failure.

weight transmission at the critical junction of an immobile and mobile spinal segment. The lumbosacral facets in quadrupeds most commonly lie in a sagittal plane. Evolutionary evidence indicates that in man the tendency is for these facets to assume a coronal plane, but for mechanical reasons it would be ideal if the lumbosacral facets were placed in a symmetrical oblique plane, since this compromise combines great stability with considerable agility.

It was found, in prepared specimens of the lumbosacral region, that facets (which on roentgenograms appeared to be oblique) were actually

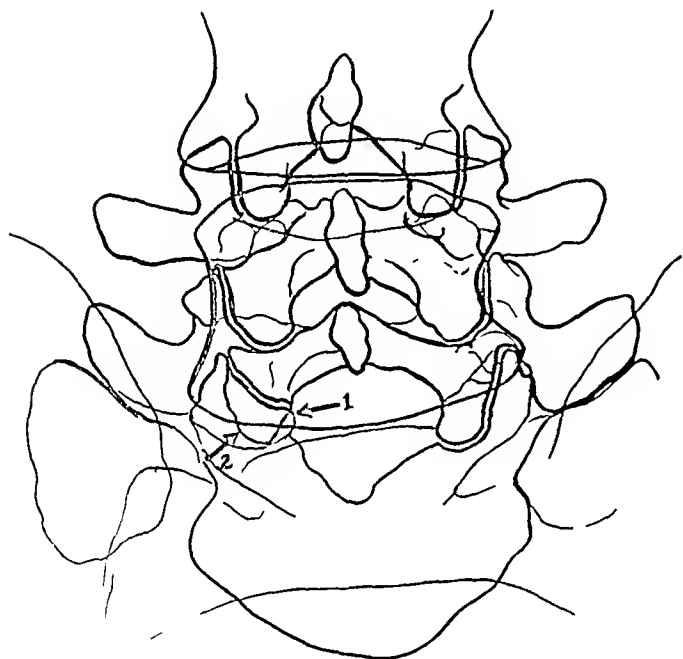


FIG. 2

1. Central margin of the sacral articular facet.

2. The inferior margin of the lumbar articular facet.

curved. As a matter of fact, no facet plane is purely oblique, sagittal, or coronal, but all have some curved component, corresponding to a segment of a cylinder, either completely or in part. These facets may appear on the roentgenograms as sagittal or coronal, depending upon which component is predominant. A pure form of one or the other is almost never found.

Variations in the plane of the posterior lumbosacral articulations are frequently difficult to detect even with stereoscopic and

oblique projection roentgenograms. Figure 1 shows an example of a roentgenogram in which these articulations appear grossly asymmetrical. A comparison of these roentgenograms with photographs of the specimens (Fig. 3) and drawings of the region (Fig. 2) should indicate the reason for possible errors in diagnosis. Slight variation in the plane of the roentgen-ray projection would cause a sagittal portion of one articulation to stand out in relief, and obscure the plane of the articulation on the opposite side. Sacral inclination is also an important and confusing factor, for the lamina and articular processes of the last lumbar vertebra may consequently appear to lie almost in a coronal direction, "end on", and the margin of the lamina and the superior margin of the sacral articulation on one or both sides may form two slightly separated lines of increased density which closely resemble the roentgenographic ap-



FIG. 3

Photograph of dried specimen showing no failure of fusion.

pearance of a defect in fusion of the neural arch or marked articular asymmetry.

Perhaps the best criterion for judging the probability of such a relationship between articular asymmetry and symptoms of pain is early evidence of degenerative arthritic changes at these joints. This is first indicated only by a narrowing and irregularity of the interarticular space and by increased density of the subarticular bone. Later a suggestion of osteo-arthritic lipping may be observed. This will be made evident by a sharpening of the normally rounded, smooth contour of the margins of the articular facets.

Asymmetry of the lumbosacral articulations may be noted in approximately one-quarter of all human spines. There are variations in degree of asymmetry, and the associated alterations in force transmission differ in significance. When the paired articular processes on one side approximate the sagittal plane, while those on the opposite side lie near a coronal plane, lumbosacral motion, as well as stresses, will be unequally divided

between the two. A coronally situated articulation can but inadequately share in flexion or extension, and with such motion the articular surfaces will be subject to trauma. The converse is true of sagittal articulations, which allow flexion and extension, but which would resist rotation and lateral motions. Asymmetry will further result in eccentric resistance to the shear stresses encountered at this point, since sagittal articulations are structurally ill-adapted for such functions. Not only weight transmission, therefore, but also spinal motions would be differently handled by asymmetrical articulations and under different conditions of activity; first one and then the other articulation would be the site of traumatic forces.

ENLARGED, ARTICULATING, OR FUSED TRANSVERSE PROCESS OF THE LAST LUMBAR VERTEBRA

Unilateral or bilateral impingement of an enlarged transverse process of the last lumbar vertebra upon either the ilium or the sacrum is frequently seen with transitional vertebrae at the lumbosacral junction. Aside from actual impingement, the enlargement of the transverse processes of the last lumbar vertebra suggests that it has simulated to this extent the form of a sacral segment. In the authors' series this was noted in eighty-eight spines, or 51.5 per cent. of those examined. In twelve, or 7 per cent. of the total series, the enlargement was unilateral; in seventy-two, or 42 per cent., bilateral; and in four, or 2.3 per cent., asymmetrical. An additional eight spines, representing only 4.5 per cent., of the group studied, showed either impingement upon or fusion with the sacrum or the ilia. In three, or 1.7 per cent., this condition was unilateral, and in five, or 2.9 per cent., it was bilateral.

The fusion of enlarged transverse processes to the sacrum does not constitute a mechanical disability, and bilateral articulation of enlarged processes with the ilia or the sacrum will normally result in no asymmetry of weight transmission. Unilateral impingement without fusion, or bilateral and asymmetrical impingement and fusion will, on the other hand, result in altered spinal mechanics. This is because a lateral fulcrum has been created. The vertebral articulations then come to lie within arcs of circles of different diameters, each circle centering at the impinging, leverlike transverse process which now acts as an accessory fulcrum, altering motion and stress transmission at the lumbosacral joint. The articulations on the side opposite to the impinging process move through a larger arc of motion and correspondingly bear a major share of the transmitted stresses. Similar derangement of motion and stress transmission results between the lateral margins of the fifth lumbar body and the articular surface of the sacrum.

VARIATIONS IN VERTEBRAL OSSIFICATION

Failure of fusion may theoretically take place wherever any two growth centers normally join, be they primary or secondary. The most

common of these are: (1) failure of fusion of the laminae, (2) failure of fusion of the laminae and pedicles, and (3) failure of fusion of the various apophyses which may remain as separate ossicles. These are of particular interest when they affect the last lumbar and first sacral segments, for here they frequently affect the stability of the spine. They assume additional importance in view of their occasional misinterpretation as fracture, and the consequent, not infrequent, medicolegal repercussions which ensue. Throughout the study of this series of 171 spines, particular attention was paid to the search for unfused neural arches, and separate ossicles about the articular processes. Of the former, only two examples were found, an incidence many times lower than that commonly reported. No cases of separate ossicles about the articular processes were seen. Bifid spinous processes were noted in seventeen sets of vertebrae, with a total of twenty-one of these anomalies, the highest incidence being at the first sacral segment (9.5 per cent.). Separate ossicles about the margins of the bodies of the vertebrae were seen in eight vertebrae.

OSTEO-ARTHRITIS

Exclusive of an individual's occupation, it has been felt that osteo-arthritis of the lumbosacral vertebrae should bear a relationship to several anatomical factors. Variations in the inclination of the sacrum, for example, could conceivably influence osteophyte production about the lumbosacral joints. In general, the opposing surfaces of the vertebral bodies of man approximate a horizontal plane, but at the lumbosacral junction the plane of this articulation averages 45 degrees from the horizontal.* Shearing stresses, therefore, add to the forces that must be resisted at the lumbosacral joint. With a sacral inclination of 45 degrees, this force averages approximately 75 per cent. of the normal transmitted body weight at this junction. Decreased inclination will reduce these shearing forces, and conversely an increased inclination will increase them. Strain against the posterior articulations should be proportionately greater and might be expected to be reflected in a greater incidence of osteo-arthritis in those spines with increased sacral inclination, but an analysis of this series indicates that this does not invariably follow. There is such slight discrepancy between the comparable degrees of arthritic change in those spines with sacral inclinations of more than or less than 45 degrees, that no conclusion as to the effect of sacral inclination is warranted.

As noted above, the preponderance of the shear stresses at the lumbosacral joint are resisted by the posterior articulations. These, if they lie either in a coronal or oblique (curved) plane, strongly resist any tendency of the last lumbar vertebra to be displaced forward. Little resistance is offered by sagittal or asymmetrical articulations,—in fact,

* The authors recognize the many ways that have been used to measure the lumbosacral angle. They felt that measuring the degree of tilt of the upper surface of the sacrum to the horizontal was best for their purpose.

with the latter, irregular concentrations of stresses occur. A statistical analysis of the degree of so-called degenerative osteo-arthritis in relation to the plane of the lumbosacral articulations in the material bears this out. Lumbosacral articulations lying in a bilateral, symmetrical, coronal plane occurred in 22.5 per cent. and showed the lowest incidence of osteo-arthritis, as evidenced by an overgrowth of bone along the joint margins. Oblique (curved) articulations were noted in 44 per cent. and were second lowest in incidence of arthritis. Asymmetrical articulations showed the highest incidence of arthritic involvement, and were observed in one-quarter of the spines examined, whereas sagittal articulations, although showing a similarly high incidence of arthritic change, were found in only 8 per cent. of the spines of this series. It should be borne in mind that the average age of the patients in this series makes the incidence of degenerative arthritis rather high.

Further, all decisions regarding the degree of arthritic involvement of the vertebral joints should be influenced by the knowledge that the roentgenographic estimations of the severity of the degenerative process tend to err on the conservative side by between 50 and 75 per cent. Thus, when arthritis is unmistakable on the roentgenogram, the disease is already moderately advanced.

SUMMARY AND CONCLUSIONS

An attempt has been made to correlate the roentgenographic and anatomical findings at the lumbosacral junction by careful comparison with dissected specimens. Besides the statistical data on the various anomalies which occur in this region, two findings were of interest. The first was that the degree of osteo-arthritis present in a given case is always a great deal more advanced than the roentgenograms would indicate, particularly as far as the posterior elements of the vertebral segments are concerned. The second was that there are confusing findings in the roentgenograms at times which, because of the varying projection of the central roentgen-ray beam and the asymmetrical development of the articular processes, will produce an appearance suggestive of failure of fusion, but in reality the segments will be found quite intact. The variations in the anatomical structure have been briefly discussed.

The oblique, coronal (curved) plane is perhaps the most desirable for the human lumbosacral articulations, and the approach to the coronal plane should be considered the "evolutionary normal".

1. KEITH, ARTHUR: *Man's Posture: Its Evolution and Disorders*. British Med. J. I, 499, 1923.

LOOSE BODY OF THE KNEE DERIVED FROM THE MENISCUS

BY EMIL D. W. HAUSER, M.D., F.A.C.S., CHICAGO, ILLINOIS

The derivation of loose bodies in the knee is not only of scientific value, but is also of definite practical interest. The scientific importance is the fact that a fragment of the meniscus, torn free so that it lies within the joint cavity, will, after a period of time, assume the characteristics of a joint mouse. The surfaces wear smooth, and the fragment gradually assumes a symmetrical shape. There is an alteration in the cartilage, so that the outer surface is laminated. The appearance of the loose fragment becomes identical with the appearance of a loose body which is derived from some other source,—such as one derived from the articular cartilage, as is the case in osteochondritis dissecans. It would appear from this, that a rough fragment of cartilage within the joint cavity is affected by the synovial fluid and the friction rub, so that it assumes typical characteristics, even though the original sources of the loose fragments may be variable.

The percentage of cure following operation for fracture of the meniscus varies from 80 to 90 per cent.¹ This leaves a definite number of cases which are not entirely relieved by surgery. In spite of the fact that this percentage is not large, it should be smaller. The author wishes to report four cases in which loose bodies were derived from the meniscus. It is evident that if the injured meniscus is removed without recognition and removal of the loose body, there will be a recurrence of symptoms.

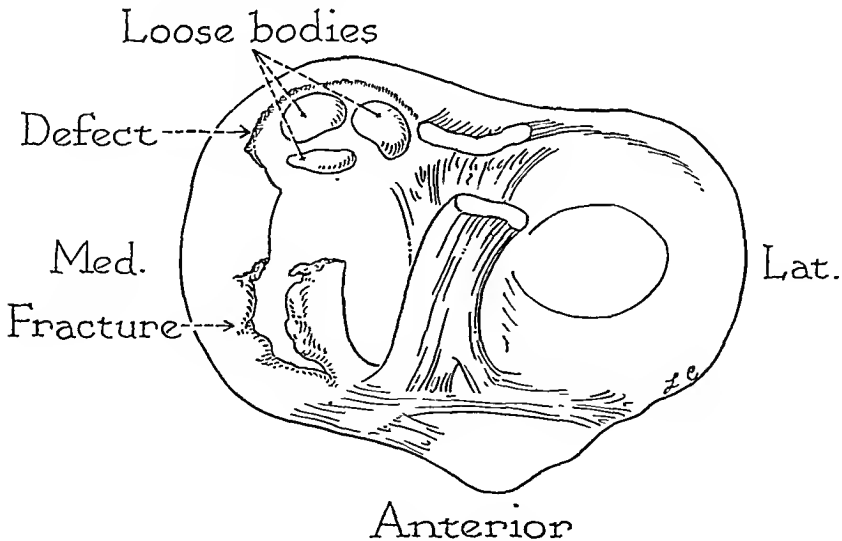


FIG. 1

Left knee. Defect in posterior aspect of meniscus and three loose bodies in posterior compartment.

CASE 1. A twenty-six-year-old medical student, ten years previously, had injured his knee at football. A diagnosis was made of an internal derangement of the left knee.

On June 21, 1934, surgical exposure revealed a thickened capsule, and an increase in joint fluid. A fracture was present in the anterior part of the cartilage (Fig. 1). The anterior half was easily removed. The posterior half was then removed and was found to be fragmented. Several small fragments about the size of half of a lima bean were seen floating in the joint fluid, and were removed. They were evidently derived from the meniscus, and the surfaces were worn smooth. The patient's recovery was uneventful, and he was allowed to go home on the fourteenth day.

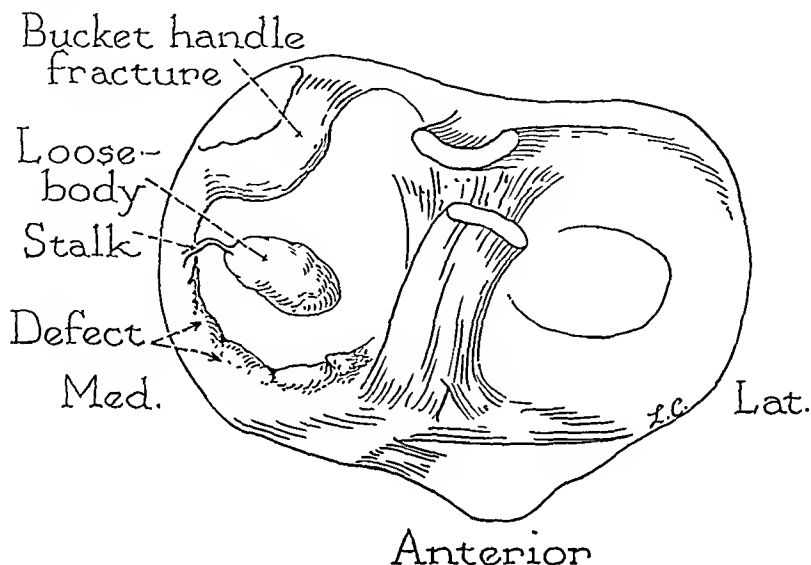


FIG. 2

Left knee. Loose body, except for small, stalk-like attachment, and the defect in meniscus from which it was derived.

In this case there were several loose bodies derived directly from the injured posterior part of the cartilage. They were still in the posterior compartment. Apparently the posterior part of the cartilage had been torn free and then was caught in between the joint, and these small fragments were gradually worn between the articular surfaces.

CASE 2. A thirty-nine-year-old man had slipped and injured his knee. He had had pain and swelling for two and one-half years. A diagnosis was made of traumatic arthritis with synovial changes and possible fracture of the medial meniscus.

On April 7, 1936, the joint cartilage was exposed and a loose body, one and two-tenths centimeters in width and two and four-tenths centimeters in length, was found in the joint cavity (Fig. 2). It was attached by a threadlike membrane to the medial meniscus. The anterior part of the medial meniscus had been torn free from its attachment. This portion of the cartilage and the loose body were removed. The incision of the capsule was elongated, the tissue retracted, and with further dissection a bucket-handle type of fracture of the posterior part of the meniscus was exposed. The entire meniscus was removed. The postoperative course was uneventful; after six weeks the patient was dismissed, and he has remained well.

This case shows the defect in the cartilage; the fragment that was torn free was attached by a very fine stock. This fragment had worn

smooth and assumed all of the characteristics typical of a joint mouse. In this way it gave evidence of the formation of a loose body derived from the meniscus.

CASE 3. A thirteen-year-old boy, three years previously, had injured his knee while jumping. He had had repeated attacks of locking. The loose body was palpable, but not demonstrable by roentgenograms.

At the time of operation, May 1, 1936, the loose body was identified and removed (Fig. 3). The knee was examined to establish where the loose body came from, and osteochondritis dissecans was ruled out. In the central half of the meniscus there was a crescent-shaped defect. The shape of the loose body showed that it was derived from this defect. The anterior part of the lateral cartilage was torn free from its attachment and there were tags extending into the knee joint. The entire meniscus was removed. The loose cartilage had been worn smooth and assumed the characteristics of an ordinary joint mouse, with the exception that its shape was a little unusual. The patient made an uneventful recovery, and he has had no trouble since.

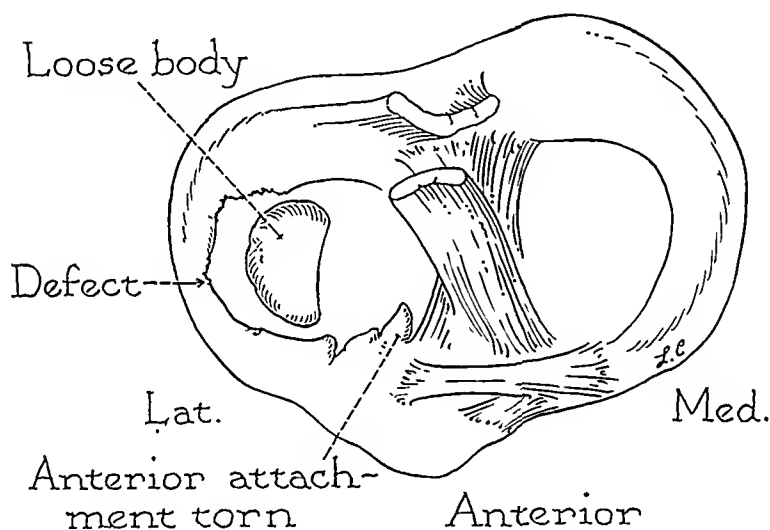


FIG. 3

Right knee. Loose body corresponding to defect in lateral meniscus.

The diagnosis in this case was a fracture of the lateral meniscus with a fragment torn free, which gradually assumed the characteristics of a joint mouse.

CASE 4. A forty-one-year-old man had injured his knee playing badminton four and one-half months previously. He had a history of knee-locking, which was not entirely relieved after manipulation. A diagnosis was made of an internal derangement of the knee, and an open operation was advised.

On October 22, 1940, a small incision was made on the medial side. The synovial membrane was thickened, and there was an increase in the synovial fluid, which was thicker than normal and had a yellowish tinge. The prepatellar fat pad showed an increase in size and a thickening of the tissue. The anterior part of the cartilage seemed loose. The cartilage was removed, but there was not sufficient change to explain the symptoms, so the wound was closed, and an incision was made on the lateral side. The anterior part of the cartilage was intact, but there was a fracture with a free end at the middle third (Fig. 4). The entire middle part of the cartilage had been torn free and

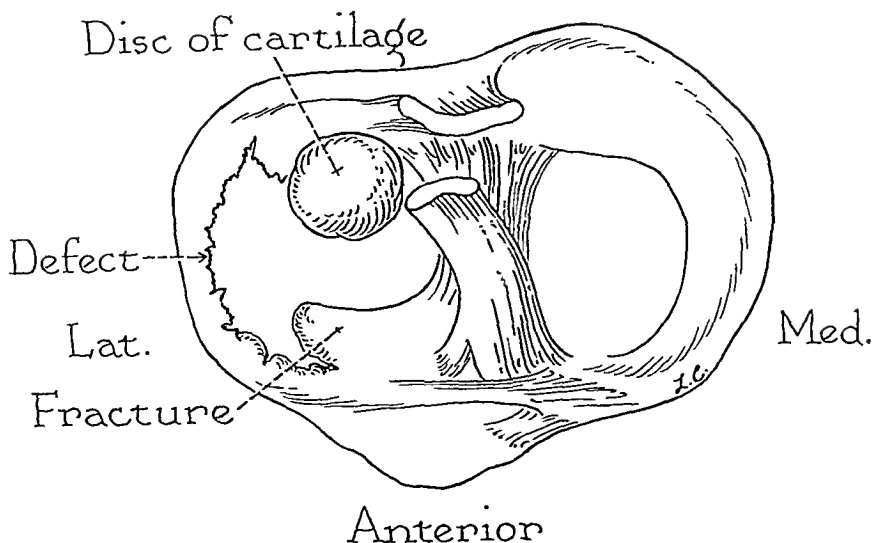


FIG. 4

Right knee. Disc of cartilage in posterior compartment, derived from central part of meniscus.

was missing. The fragmentary margin was removed. In the posterior part there was a fragment that was intact and this was removed. Posteriorly and lying on the surface of the tibial cartilage was a thickened disc about the size of a nickel. This disc apparently caused the block in flexion. The disc was lifted by means of the end of a scissors, and the margin, still attached posteriorly, was dissected free by means of a special dissecting knife which has a cutting edge on the end. This disc was then removed and the knee could be flexed, as well as extended. The knee was then fully flexed and extended, and examined repeatedly to see if there were any further loose bodies present.

This case demonstrates an unusual condition in which there was a bucket-handle type of fracture of the meniscus which had torn free at its anterior end. Apparently, in the course of the manipulation, the bucket-handle portion had been forced posteriorly and had been caught between the articular surfaces, where it had been gradually ground smooth on both sides and worn thin at the edge to form a disclike body. Although this body was still attached at the posterior margin of the cartilage, it acted as a loose body to interfere with movement at the knee joint.

These four cases show the presence of loose bodies in the knee joint caused by injury of the meniscus. A fragment, torn free, migrated into the joint cavity, where bathing in joint fluid and the action of the articular surfaces gradually altered the fragment until it was smooth and symmetrical, and assumed the appearance characteristic of a joint mouse. The clinical significance of a loose cartilage is that it must be found and removed; otherwise symptoms will continue, even though the injured meniscus has been satisfactorily removed. This in turn emphasizes the importance, in case of a fractured meniscus, of removing the entire meniscus and of accounting for all of the tissue.

1. FISHER, A. G. TIMBRELL: *Internal Derangements of the Knee-Joint*. Ed. 2, pp. 98-101. New York, Macmillan Co., 1933.

EXCISION OF THE PATELLA

SOME EXPERIMENTAL AND ANATOMICAL OBSERVATIONS

BY JOHN BRUCE, F.A.C.S., LIEUT.-COLONEL, R.A.M.C., EDINBURGH, SCOTLAND

Assistant Surgeon, Edinburgh Royal Infirmary

AND ROBERT WALMSLEY, M.D., MAJOR, R.A.M.C., EDINBURGH, SCOTLAND

Lecturer in Anatomy, University of Edinburgh

The widespread practice of a new surgical procedure has often served to focus attention on limitations in our knowledge of the structures concerned. This is certainly the case with regard to the patella. The vogue of patellar excision in cases of fracture has become very widespread, and the operation has also been recommended and used for sundry other disabilities of the knee joint, in consequence of the apparently innocuous nature of the procedure. It is probable that, as in most other operations, indications for it will eventually be established by a process of trial and error; but in the meantime, it seems that the success of the method has led to much conjecture and confusion with regard to certain aspects of the function, and even of the gross anatomy of this somewhat mysterious bone.

It appears to the authors that this is a suitable time to take stock, for in recent years, removal of the patella has been urged as a means of obtaining drainage in suppurative arthritis of the knee, and also as an easy and suitable alternative to displacement of the patella in major arthrotomy of the knee joint¹². Underlying these recent applications of the operation is the impression that the method is easy and without harm. Indeed, Mader claims that it is an ideal step in arthrotomy because it gives rise to no disability and permits of a short convalescent period. The operation has also been carried out in recent years for osteo-arthritis of the knee joint, and for habitual subluxation of the patella, though reports of its success in these disabilities are less enthusiastic.

The authors became interested in the subject of the removal of the patella and its effects in 1936 when they were engaged upon some investigations concerning the growth of bone. It was their belief that, if the patella served any useful purpose—which they supposed it did—then it would regenerate after removal, or else be replaced, as is a meniscus of the knee joint, by a structure of similar size, or shape, or function.

Carey, Zeit, and McGrath in 1927 found that in young puppies the removal of the cartilaginous patella was followed by the development of a similar mass of cartilage, if free movement was permitted at the joint. They drew the conclusion, apparently justifiably, that the presence of certain mechanical conditions could determine the formation of a cartilaginous substitute from “indifferent” mesodermal or fibrous-tissue cells.

In 1933 Niven cultivated *in vitro* the mesenchyme destined to form the limb of the chicken embryo, and found that as the living culture grew, it differentiated, and a bony patella gradually appeared. This led her to conclude, again with every justification, that the primary development of the patella was the result of intrinsic and inherited factors, and was quite independent of mechanical considerations.

These two observations are not actually contradictory, for it may be quite true that the initial development of the patella is predetermined, whereas the loss of the original patella is followed by the development of a similar type of structure, provided certain mechanical conditions obtain.

Excision of the bone for fracture was advocated in 1937 by Brooke, and it was obvious that the early results of this method were of a strikingly high quality. As a result of his own experience Brooke was led to certain conclusions, and ceased to regard the patella as having any functional significance in the mechanics of the knee joint; he considered it merely a useless appendage.

In 1908, Murphy of Chicago reported several cases of removal of the patella for tuberculous osteitis. In this paper, he indicated that Putz of Strasbourg in 1860 had practised the method, and discovered, in consequence, that the patella was not essential for gait. To this view Murphy himself inclined, since in his own cases the function of the joint after operation was satisfactory. Moreover he went further, alleging that the theory, which held that the patella served to facilitate the sliding of the quadriceps tendon on the femur, and assisted the quadriceps in transmitting its action to the leg, was no longer tenable. In this particular point of view, he was in agreement with Joachimstal, who had encountered quite normal function in cases of congenital absence of the patella; the same observer, incidentally, showed that certain animals which used the quadriceps extensively had no patella. In Murphy's communication, there is one other reference of considerable interest in connection with the subject of this paper. Apparently it was common knowledge at the end of the last century that the patella could be reproduced if a "subaponeurotic" method of removal was employed. François, according to Murphy, had been the first to show that this was so; the substitute, he discovered, could be bony or cartilaginous; it was generally smaller, but "physiologically" it was the equivalent of the excised bone.

An interesting review of the whole subject of fracture of the patella was contributed by Heineck in 1909. He had been able to collect seventeen cases in which the patella had been removed during the preceding ten years, in ten of these cases because of fracture. The results in all these cases were rated good to excellent, but Rogers, Scudder, Le Boutillier, and Rouvillois drew attention to some consequent limitation of flexion. Heineck himself observed that under certain circumstances the patella was unnecessary for locomotion, but that its removal was invariably followed by impairment of power, and by some functional loss. Among the possible ill effects, he mentioned lack of protection to the knee joint,

disturbance of leverage, so far as the quadriceps is concerned, and loss of the usual pulley effect. Heineck's final judgment was to the effect that removal of the patella was quite unjustifiable in the case of uncomplicated fractures; his view received additional support from the experience of himself and others, that in fifty-three cases of congenital absence of the patella there was some functional incapacity of the knee joint.

Removal of the patella in chronic arthritis was first suggested by Ludloff in 1926. He claimed good results for the operation, and found it useful also in recurrent dislocation of the patella. Since its "modern" reintroduction, the method has again been applied to these two conditions, with varying results, although Watson-Jones recommends it for osteoarthritis confined to the patellofemoral compartment of the joint.

The value both of total, and even of partial removal of the patella in cases of recent fractures was also stressed by Blodgett and Fairchild in 1936. Apart from Murphy who quotes François as his authority, these are the only authors to raise the question of possible regeneration of the patella after resection. In several of their cases, scattered areas of new bone formation were demonstrated roentgenographically at the site of the operation.

It is apparent that there is well-authenticated evidence that removal of the patella does not grossly disturb the function of the knee joint. In fact, in Brooke's experience, the very opposite obtains, and the movement of the joint and the strength of the quadriceps is actually increased after the operation. Brooke used these findings to support the view of DeVriese that, since the infant's patella is relatively much larger than that of the adult, the bone is in the process of phylogenetic reduction, and has no functional significance. Furthermore, since the activity of the quadriceps appeared to be enhanced by removal of the patella, it was concluded that a functional association between the two structures was non-existent, and it was a short step from this to postulate an actual anatomical dissociation. According to Brooke—and the assertion is supported by his illustration—the patella is not at all in anatomical connection with the quadriceps, but is entirely separate from it, and lies actually behind the tendon in a loose fatty tissue, the presence of which renders the enucleation of the bone a procedure of great simplicity.

This work of Brooke's received the distinguished support of Hey Groves who examined two specimens of the knee joint prepared for him by Whitnall. These convinced him that the patella and the quadriceps have only a very loose relationship the one to the other, neither the upper nor the lower margin of the patella affording direct attachment to quadriceps fibers. These views did not conform to those which the present authors had arrived at from observations of a limited amount of material prior to the publication of these papers. Since then, they have extended the scope of their investigations, and it seems to them that the time is now ripe for a review of the fundamental points at issue. These are:

1. The exact relation of the quadriceps tendon to the patella
2. The effects and sequelae of removal of the patella.
3. The functional significance of the patella.

The first of these problems has been examined in the light of the development and the adult anatomy of the bone; the second by experimental means; while the third is, to the authors' minds, clarified by a consideration of the other findings.

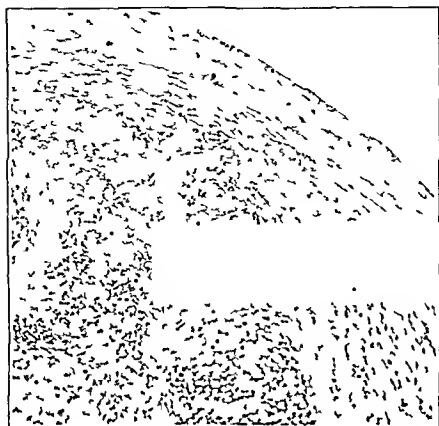


FIG. 1

Photomicrograph of the knee region of a 20-millimeter embryo showing condensation of cells in the quadriceps tendon at the site of the future patella



FIG 2

Photomicrograph of the knee of a 23.4-millimeter embryo. The patellar anlage is now quite obvious

The point at issue is not whether removal is better than suture in the case of fracture, but whether the good results which attend the operation have led to looseness and inaccuracy with regard to the importance and the anatomy of the bone, and whether enthusiasm for a new method has led to its employment in unsuitable circumstances, and despite possible ill effects.

THE DEVELOPMENT OF THE PATELLA

The complicated structure of the knee joint has stimulated much research on the subject of its development. The patella has usually been regarded as the largest of the sesamoid bones, developed and, in adults, situated in the tendon of the quadriceps femoris, but this is the view which has been challenged by the observations of Brooke and Hey Groves.

A large series of human specimens have therefore been investigated. They were prepared especially for a study of the development of the knee joint, and all the smaller specimens (up to sixty millimeters crown-rump length) were cut serially, one knee joint of each specimen being cut in the sagittal plane, and the other in the coronal plane. In the larger specimens, sections were taken at different levels throughout the joint, and numerous dissections were also made. Dissections and sections of adult knee joints have also been studied

The mesenchymatous anlage of the quadriceps femoris is present in

the twenty-millimeter human foetus, and the continuity of its tendon with the perichondrium of the tibia is clearly established (Fig. 1). Although there is, as yet, no definite precartilaginous patella, there is a slight relative increase in the cellular content of that part of the quadriceps tendon which lies in front of the lower end of the femur. This portion of the tendon undergoes a rapid change in successively older foetuses, and in the twenty-four-millimeter foetus there is a well-defined precartilaginous patella. The patella of a foetus twenty-three and four-tenths millimeters

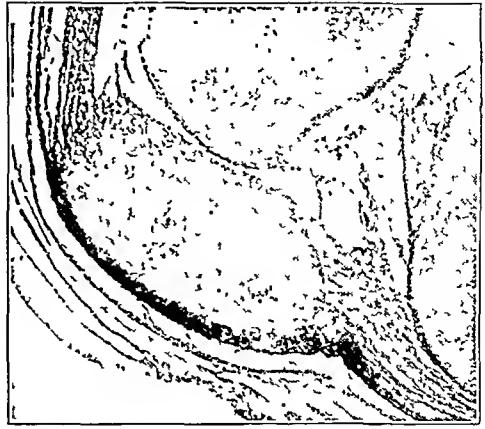


FIG. 3

Photomicrograph of knee of 40-millimeter embryo. The patella is now well formed, and there is a definite joint space between the femur and the patella. The strata of the quadriceps are well marked.

long (Fig. 2) is represented by an aggregation of rounded and oval cells at the upper and lower ends of which there is a transition zone, where the cells undergo a gradual change in form. There is no sharp line of demarcation between the patella and the tissues of the quadriceps above and below it. Between the patellar anlage and the femur there is loose mesenchymatous tissue which is continued upward as far as the origin of the vasti. Below, it is continuous with the mesenchymatous tissue of the joint plate. On the medial and lateral sides, this tissue blends with the expansions from the vasti, so that there is no evidence of a synovial cavity. The smallest foetus in which a cartilaginous nucleus has been observed in the patella is a thirty-millimeter foetus. In this foetus the cartilaginous patella lies in the deep part of the quadriceps tendon in front of the distal end of the femur. From this stage onward the cartilaginous patella grows rapidly and even



FIG. 4

Photomicrograph of the knee of a 90-millimeter embryo. The patellofemoral synovial cavity is now complete. The patella is relatively great in size in contrast with the lower end of the femur. It is still closely associated with the quadriceps tendon

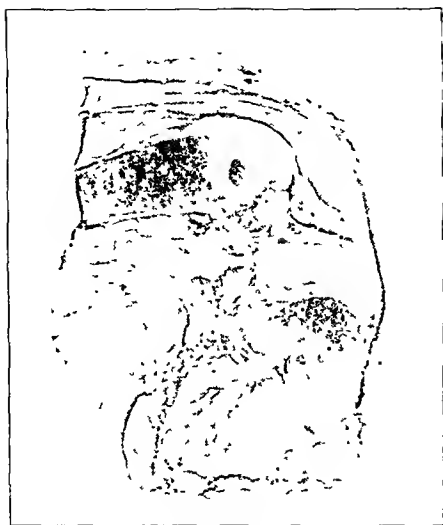


FIG. 5

Photograph of a sagittal section of the knee joint of a full-time foetus to show the form and relative size of the patella at birth.

commenced to break down at its periphery, and this constituted the first sign of the retropatellar part of the synovial cavity (Fig. 3). The quadriceps at this stage is well developed, and descends toward the patella in three strata. The *superficial stratum* is the thinnest and becomes separated from the main muscle mass about seventy micra above the patella. It extends downward in front, is quite independent of the patella, and breaks up into a series of fine processes which ramify in the loose subcutaneous tissue in front of the lower part of the ligamentum patellae. As this lamina passes downward it loses the dark-staining reaction of the muscle fibers, and near its termination becomes very vascular. The *intermediate stratum* becomes thinner as it descends, and passing towards the anterior surface of the patella becomes continuous with the fibrous lamina that lies in front of the cartilage. The *deep stratum* retains its muscular characteristics as far as its attachment to the upper border of the patella, where there is a gradual transition between its cells and those of the cartilage. The ligamentum patellae is formed in part by the continuation downward of the fibrous stratum that is on the front of the patella, and in part by fibers which arise from the lower border of the patella. The tendon descends to the front of the upper part of the tibia where it blends with the perichondrium; the perichondrium is much thicker below the attachment of the tendon than it is above it.

From the forty-millimeter stage onward the quadriceps retains the relationship to the patella which has just been described. The synovial cavity increases in size by the breaking down of the joint plate between the patella and the femur, and it also extends beyond the periphery of the patella, especially above it (Fig. 4). The patella increases in relative size until about the sixth month of foetal life, when it commences to un-

by the thirty-two-millimeter stage it is a well-defined structure lying within the tendon. Up to this stage there is no synovial cavity in the knee joint, and the patella is separated from the femur by loose mesenchyme which undergoes condensation in successively older stages until in the thirty-five-millimeter foetus there is a zone of closely aggregated cells between the cartilaginous patella and the femur. During the next five millimeters of growth this zone becomes relatively thinner, so as to form a disc of cells which is exactly similar to the primitive joint plate of the simple diarthrodial joint. In one of the forty-millimeter specimens which were examined, the joint plate had already

dergo a slight, but definite, relative diminution; its form and size at birth are shown in Figure 5. During the first few years of life the bone is still relatively large, and, according to De Vriese, does not assume its adult proportions until about the fifteenth year.

THE RELATIONSHIP OF THE PATELLA TO THE QUADRICEPS FEMORIS IN THE ADULT

A review of the development leaves no doubt as to the close relationship between the patella and the quadriceps in the developing embryo. These findings, however, are in sharp contrast to the opinions of Brooke and Hey Groves, and the authors decided to pursue the investigations in the adult as well. This was done both by dissection and sagittal sections in adult cadavera.

A short distance above the patella the quadriceps muscle has three strata (Fig. 6). The superficial stratum is formed by the rectus femoris, the middle by the vastus medialis and vastus lateralis, and the deep stratum by the vastus intermedius.

An aponeurosis of insertion is present on the deep surface, and along the anterior border of the lower half of the vastus lateralis, about three centimeters above the patella, it fuses with the adjacent part of the aponeurosis of the vastus medialis, which appears near the lower end of the muscle. The combined aponeurosis of the two muscles is in the form of a series of laminae which descend to be attached to the upper border of the patella, the one behind the other. The remaining parts of the vastus lateralis and vastus medialis are inserted partly into the rectus tendon, but chiefly into the lateral and medial borders of the patella, and also, by aponeurotic expansions—the retinacula—into the condyles of the tibia. The muscle fibers of the vastus medialis, as is well known, extend farther downward than those of the lateralis.

The lower part of the vastus intermedius is covered by the combined aponeurosis of the vastus lateralis and vastus medialis, and, although it is adherent to this aponeurosis, there is no interchange of fibers, and the

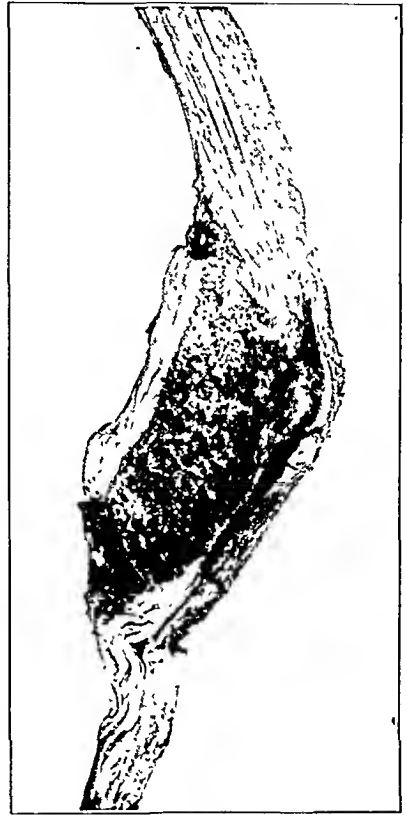


FIG. 6

Section through the quadriceps and patella of an adult. The quadriceps strata are distinctly shown and the attachment of the fibers to the upper border of the patella is obvious.

two strata can be separated from each other. The tendon of the vastus intermedius is inserted independently into the upper border of the patella behind the vastus lateralis and vastus medialis. The *superficial* part of



FIG. 7

Roentgenogram of the knee four weeks after removal of the patella. The patellar surface of the femur shows early erosion.

the quadriceps tendon consists in the main of the rectus femoris, but it has contributions also from the superficial parts of the vastus lateralis and vastus medialis. About five centimeters above the patella the tendon of the rectus widens into a thin broad aponeurosis which receives fibers of the vasti, and descends in front and on each side of the patella. Immediately above the patella the rectus aponeurosis is firmly attached to the aponeuroses of the vastus lateralis and vastus medialis, but the two strata can be defined accurately by sharp dissection. The rectus, moreover, is firmly attached to the upper part of the front of the patella, but it usually can be easily stripped from the lower part of the front of the bone. On each side of the patella, the rectus expansion blends with the deep fascia—being especially intimately related to the iliotibial tract on its lateral side—and is attached with it to the condyles of the tibia.

The main part of the ligamentum patellae is formed by fibers which are attached above to the lower part of the patella, but its superficial fibers are the downward continuation of the rectus femoris. The ligamentum patellae is inserted into the upper part of the tuberosity of the tibia.

THE PRESENT EXPERIMENTAL OBSERVATIONS

Removal of the patella was carried out in a series of fourteen rabbits. The operative techniques employed varied slightly, but were based upon the procedures used in clinical practice. An anterior mid-line incision was the standard approach, and the resection of the bone was variously accomplished. In the majority, the patella and the aponeurosis covering it, together with the patellar retinacula, were divided transversely, and each half of the bone was then enucleated subaponeurotically. To effect this, it was necessary to divide the synovial attachments to the margins of the patella, and also to detach by sharp dissection the quadriceps fibers inserted into its proximal edge.

In a few cases the bone was removed unbroken after simple division of the aponeurosis, and, in several, the bone was removed entirely by cutting it out of the quadriceps tendon along with its covering aponeurosis.

The gap in the quadriceps and the capsule was closed in all save one case by a transverse line of sutures, generally of catgut; though in one or two rabbits, linen thread was preferred. In one case only, the gap was

closed in the vertical axis. This case has been disregarded in the review. The transverse closure of the gap tended to ensure the continued activity of the quadriceps fibers formerly attached to the patella, and implied that the suture line was being exposed to the stimulus of quadriceps contraction.

After operation, the animals were allowed complete freedom of activity. In order to encourage the free use of the limb, the rabbits were housed in a run equipped with a sandpit, and in all save one of the animals, the quadriceps resumed its normal functional activity. The electrical responses of the muscle were tested in each case, and found to be normal, and in each case, it was confirmed that the quadriceps was pulling through to its insertion in the tibia.

Roentgenographic examination of the hind limbs was carried out immediately after operation, to verify that no part of the bone had been left *in situ*. Thereafter, roentgenograms were taken at intervals of a month, and again at the time the animals were killed, which varied from seven days to twenty months after removal of the patella. After death, the macroscopic and microscopic changes in the knee were studied.

EXPERIMENTAL FINDINGS

1. *Roentgenographic Changes in the Patellar Surface of the Femur and the Quadriceps Tendon*

Thirteen of the fourteen rabbits of the series showed changes in the patellar surface of the femur, and in some cases these changes were observed to begin as early as one month after the removal of the patella (Fig. 7). The rabbit, which did not show any roentgenographic change, had been killed seven days after the removal of the patella. The changes, as seen roentgenographically, were mainly localized to the lips of the patellar surface, one or both of which showed indentations and general irregularity (Fig. 8).

In the quadriceps of the operated limbs of three of the rabbits (Nos. 1, 13, and 29), a small shadow appeared bearing approximately the same position relative to the joint as the patella. In rabbit No. 1, which was twelve weeks old at the time of the operation, the shadow was seen four weeks after the removal of the bone, and gradually increased in size during the succeeding months. Even after that time, however, the shadow was little more than half the length and less than half the thickness of the normal patella of the other limb.

In rabbit No. 13, which was six weeks old at the time of operation, the shadow did not



FIG. 8

Roentgenogram of knee twelve months after excision of the patella. There is well-marked erosion of the patellar surface of the femur. There is also some new bone formation in the quadriceps tendon.

appear until the fifth month. It was then of a circular form with a diameter of two millimeters, and until the time of death, some fifteen months later, it showed no appreciable increase in size, though it became more dense.

The earliest change in rabbit No. 29, aged ten weeks at the time of operation, was only observed in the quadriceps eleven months after the removal of the patella. A small bony shadow was seen, but this shadow did not grow in size, and at the time of death, some two months later, was precisely the same as it was when first observed (Fig. 9). Nevertheless, close examination of the roentgenogram shows an obvious soft-tissue shadow surrounding the bony nucleus and having virtually the same size as the normal patella. On clinical examination, there was a mass in the quadriceps indistinguishable from the patella of the opposite side.

2. *Naked-Eye and Histological Observations*

After each rabbit had been killed both knee joints were isolated by dividing the femur about two centimeters above the joint, and the tibia and fibula about one centimeter below it. The normal knee joint was used in each case as a control and preserved in 10-per-cent. formalin. In five

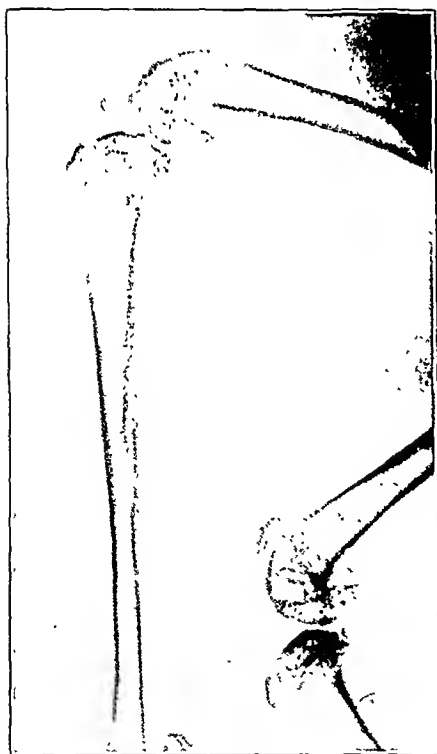


FIG. 9

Roentgenogram of rabbit No. 29. There is a small bony nucleus, but an obvious soft-tissue mass, which corresponds to a firm mass embedded in the quadriceps.

of the joints, on the side of operation, the quadriceps was detached from the femur and tibia, so that the articular surface of the femur and deep surface of the quadriceps tendon might be examined macroscopically. In each of them the naked-eye appearance and the consistency of the quadriceps were noted, and finally longitudinal sections were prepared. In the remaining nine rabbits, the knee joints were fixed in formalin, decalcified in 3-per-cent. nitric acid, and embedded in paraffin. A series of sagittal sections ten micra thick were then made through the appropriate part of the joint so as to demonstrate the microscopic changes in the patellar surface of the femur and the adjacent part of the quadriceps tendon.

In the interest of the experiments it was not desirable to interfere with the relationship of the quadriceps tendon to the femur in all of the limbs, but in five of them the quadriceps muscle was detached from the femur and the tibia, and a full exposure made

of the articular cartilage at the lower end of the femur. The macroscopic findings in these specimens confirmed what had been noted in the roentgenograms, and also showed the full extent of the changes. The five specimens all showed degeneration and ulceration of the articular cartilage of the patellar surface of the femur, with exposure of the subjacent bone. The striking feature of the process, however, was its constant localization to the patellar surface of the femur (Fig. 10).

The degenerative changes in the cartilage were confirmed by the microscopic sections which were made of the knee joints. In some places, the cartilage had completely disappeared, as well as the compact bone, so that the lamellae of the spongy bone and the intervening spaces were exposed. In many of the exposed bony lamellae there was a marked proliferation of the



FIG. 10-A



FIG. 10-B

Drawings of lower end of the femur to show the degenerative changes at the patellar surface of the femur.

bone corpuscles. These phenomena represent a particularly vicious form of chronic arthritis, and it may be concluded that in the rabbit this is the almost invariable sequel to removal of the patella.

The shadows which were observed roentgenographically in positions relatively similar to the resected patellae in rabbits Nos. 1, 13, and 29, have been confirmed, by microscopic examination, as bone. In each case the bony nodule lay in the substance of the quadriceps tendon at the level of the femoral condyles (Fig. 11). The bony nodules were, however, uniformly surrounded by quadriceps tissue as they lay in the superficial part of the tendon, and were separated from the femur by a part of it.

The bone of the largest of the nodules was relatively compact, but in the others it was less so, and the cavernous cavities were of an irregular

ovoid form. Immediately subjacent to the bone there was an irregular layer of cartilage, which gradually blended with the surrounding fibrous tissue. The part of the quadriceps, therefore, which articulated with the patellar surface of the femur had been converted into fibrocartilage.

In the other rabbits of the series,—that is, in those where no new bone growth was demonstrated roentgenographically, the patellar part of the quadriceps tendon was formed of fibrocartilage. The relative proportions of fibrous tissue and cartilage showed much variation in the different rabbits, but the cartilaginous element was relatively greatest in those animals which had been kept alive longest after the operation.



FIG. 11

Photomicrograph of a long section through knee joint. The presence of a bony nodule in the quadriceps is well shown.

DISCUSSION

These studies of the development of the patella have shown beyond any doubt that the bone develops as an integral part of the quadriceps muscle, and the authors' observations on adult human material have further demonstrated that it remains an essential part of the extensor apparatus of the knee. This, of course, was the general conception, though it is now quite contrary to the views of Brooke, Hey Groves, and Watson-Jones. This difference of opinion does not, of course, affect the problem of the treatment of a fractured patella. When the bone is broken, it is not the fracture itself, but the damage to

the extensor mechanism of the knee which is the significant feature of the injury, and repair is admittedly made easier by removal of the bone fragments.

It would be unfortunate, however, if clinical teaching were to become dissociated from the facts of anatomy, and it also would be difficult to explain certain well-recognized clinical phenomena and experiences in injuries about this region if it were assumed that the patella was quite separate from the quadriceps both in structure and in function.

Rupture of the quadriceps tendon affords some further support for the close association between patella and quadriceps. The lesion is an alternative one to fracture of the patella, but in striking contrast to the fracture, it is relatively infrequent. James assessed its occurrence as four to 318 by comparison with the bone lesion, and this in itself would be extraordinary if the muscle were not attached very strongly indeed to the bone. The muscle rupture occurs generally in men over middle age, and

the fact suggests that the tendon has previously been so weakened by degenerative changes that its resistance at the time of injury is less than that of the bone,—a state of affairs not generally obtaining. In a case of ruptured quadriceps in the care of one of us (J. B.), the operation revealed a fringe of strong fibers attached to the upper border of the patella, and direct suture was on this account possible and successful.

In view of the intimate place of the patella in the quadriceps apparatus, one naturally wonders how removal of the bone leaves as competent a knee joint as it appears to do. In the case of resection for fracture, this is not perhaps so surprising. In this injury, since the reconstitution of the extensor mechanism is the essential object of surgical treatment, the repair of the important part of this—the quadriceps tendon—is certainly facilitated by removal of the bone. Simple suture of the bone has also decided disadvantages. It can hardly be effected without the creation of a ridge or uneven area on its articular surface, and this leads in many cases to a local osteo-arthritis of the patellofemoral compartment of the knee joint.

The authors' experimental observations suggest, however, that osteo-arthritic changes are also to be anticipated following the removal of the bone. This is possibly unimportant in the case of fracture where the alternative method has the same effect and to an even greater degree. Nevertheless, it does suggest that removal of the patella should not be undertaken without proper indication,—certainly not for the purpose of securing access in the course of a so-called "wide" exposure of the joint. Its employment in osteo-arthritis is again open to question, since there appears to be at least some risk of aggravating, rather than relieving, the condition.

The occurrence of sharply localized degenerative changes in the articular cartilage after removal of the patella, suggests that, apart from, or in addition to, its other functions, the bone exercises at least a protective rôle so far as the patellar surface of the femur is concerned. It has generally been assumed that the patella formed a sort of pulley which maintained the tendon of the quadriceps in front of the axis of movement of the joint, and so increased its effectiveness. Gray states, "The patella is a great defence to the front of the knee joint; it also increases the leverage of the quadriceps". The evidence at the authors's disposal suggests that the protective function is the more important. Removal of the bone, for example, does not, to begin with, seriously if at all, affect the power of the joint movements, whereas the obvious changes in the articular cartilage indicate that fairly decisive harm results from its absence.

The likely cause of the damage to the femoral surface, after removal of the bone, is the friction of the quadriceps tendon, though the movement of the patella over the lower end of the femur during the act of flexion of the knee, and the relatively larger size of the bone in infancy, when kneeling is common and creeping the usual mode of progression, suggest that it may protect the articular surface from more direct external trauma. The

principal rôle of articular cartilage, with which the deep surface of the patella is of course clothed, is that of a cushion to absorb and dissipate pressure, and the cartilage of the patella is probably no exception to the rule.

The authors are satisfied, from their experiments, that, in the rabbit at least, there is an attempt at partial replacement of the patella following removal of the bone. The extent of this replacement varies greatly. Sometimes the new structure is bony, and at other times is composed of fibrocartilage. It seems that this is a further indication of its essential part in the joint economy. So far as is known, there has not been a detailed clinical or roentgenographic investigation on this point in the human subject, though one case of regeneration has now been reported by Mehriz. The authors have themselves encountered cases in which a very hard mobile discoid mass developed in the quadriceps tendon at intervals after resection of the patella for fracture. Roentgenographic examination was negative, and it was concluded that the disc was cartilaginous. The whole question requires further study, however, and the outbreak of hostilities prevented this part of the investigation being pursued to a definite conclusion.

SUMMARY

1. The patella develops as a part of the quadriceps apparatus.
2. In the adult, it retains a close association with the muscle and with certain of the muscle fibers. Tendon fibers are directly attached to it
3. It has to be separated from the muscle by sharp dissection which divides the muscular and tendinous insertions.
4. Removal of the patella in the rabbit is followed by degenerative changes in the articular cartilage of the patellar surface of the femur, but not by any apparent change in gait or in joint efficiency.
5. This suggests that the principal function of the patella is protective.
6. Removal of the patella is also followed by attempts at regeneration, which sometimes culminate in the development of a bony structure of appreciable size. In other cases, a fibrocartilaginous change takes place in the quadriceps tendon at the former site of the patella.
7. It is suggested that further investigation is necessary in the human subject, to determine the extent of the degenerative changes, before the operation is practised widely for conditions other than fracture or serious organic diseases of the bone itself.

The authors wish to express sincere thanks to their respective chiefs, Prof. Sir John Fraser, K.C.V.O., and Prof. J. C. Brash, for their help and advice in this study. The authors are also grateful to Miss Mann, C.S.M.M.G., for undertaking the unusual task of testing the electrical responses of the quadriceps in each rabbit. Mr. John Borthwick and Mr. D. B. Smith, the Technical Assistants in the two Departments, have afforded great assistance in the matter of illustrations.

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STENOSING TENOVAGINITIS OF THE THUMB IN INFANTS *

BY ISADORE ZADEK, M.D., NEW YORK, N. Y.

The striking feature of this condition is its manifestation in a flexion deformity of the interphalangeal joint of the thumb. There is also some associated pain on attempted passive extension of the joint,—the patient being unable to extend it actively. In 1936, Jahss included reports of several of these patients in an article entitled "Trigger Finger in Children". The designation "trigger finger" implies a "snapping" which has not been present in patients whom the author has seen in infancy. There is no clear-cut history of injury to indicate a causal relationship.

In the usual type of tenovaginitis as seen in the hands of *adults*, two locations are common,—one is the short abductors and extensors of the thumb, and the other, one of the long flexor tendons of a finger or thumb. Both the sheath and the enclosed tendon are involved. The flexor tendon sometimes shows wartlike projections of granulation tissue attached to the tendon, and at other times a thickened sheath with an irregular inner surface surrounding the tendons.

When the involvement is in the abductor extensor group of the thumb at the styloid of the radius, the chief involvement is in the sheaths with a thin, pinkish, nebulous layer of tissue surrounding and attached to the tendons themselves. These patients do not show any snapping.

The snapping occurs when there is involvement of the flexor tendons with an incongruity between the surface of the tendon and the intimate surrounding sheath,—the snap being produced by the passing of the disproportionate thickened tendon through the narrowed sheath, so that it may occur on flexion or extension or both.

In the stenosing tenovaginitis in *infants*, the author has never seen a snapping thumb, though mechanically, it might be expected. The thumb presents a fixed deformity with the terminal phalanx flexed on the proximal phalanx at about 140 degrees. By the uninitiated, this is usually considered to be a dislocation. A thickening is felt on the flexor surface at the first metacarpophalangeal joint which gives the impression of a hypertrophied sesamoid. Pressure against this thickened area causes discomfort. When the thumb is forcibly extended passively, the skin over this thickened area becomes blanched and the flexor tendon distal to the swelling becomes taut. There is no difficulty in completely flexing the thumb, but further extension is limited.

Two cases in infants, showing an unusual development, are reported. At the time when operation was indicated because of the involvement of one thumb, examination showed that there was thickening over the volar surface of the first metacarpophalangeal joint of the opposite thumb, al-

* Read before the Section of Orthopaedic Surgery, New York Academy of Medicine, in conjunction with the Philadelphia Orthopaedic Club, November 21, 1941.

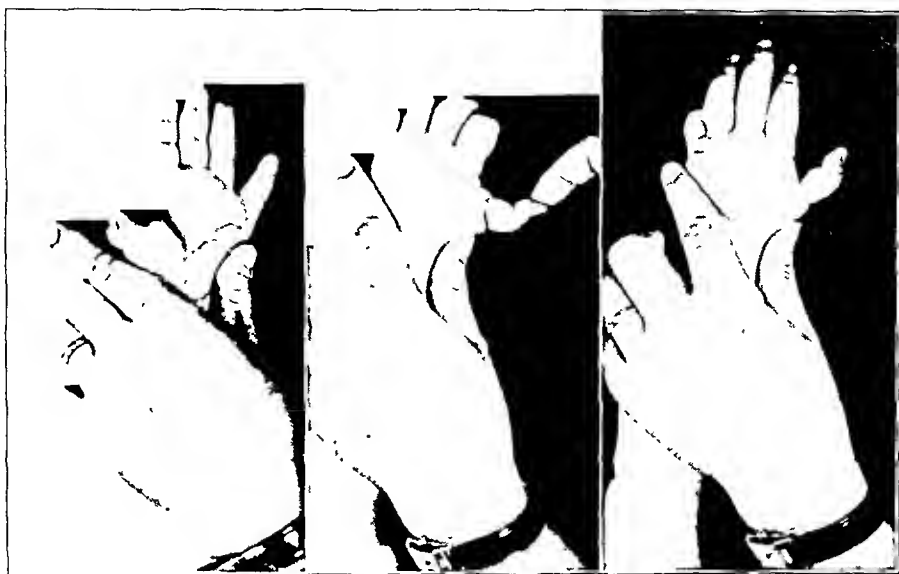


FIG. 1

Showing the fixed flexion deformity of the thumb.

most as prominent as on the side complained of, but there were no symptoms. A year later, the deformity and involvement of the opposite thumb was manifest in one patient; the other shows the swelling but is still almost symptomless.

CASE HISTORIES

CASE 1. E. S., female, aged twenty-three months, was first seen September 18, 1939. Four weeks previously, she had injured her left thumb while playing under a table. Four hours later, it was swollen and bent. The child was taken to a hospital where the thumb was stretched, and a splint was applied; this was repeated several times under the mistaken diagnosis of a dislocation. The deformity of the thumb increased.

The thumb was found flexed at the interphalangeal joint to 125 degrees. It could be extended to 150 degrees. Flexion was not limited, but on further passive extension, the flexor pollicis longus was found to be quite taut from the first metacarpophalangeal joint distally. There was a swelling over the flexor surface of the first metacarpophalangeal joint which had the "feel" of a large sesamoid bone. It was somewhat movable and roughly the size of a bean. The skin over the swelling blanched under tension. No snapping was present.

She had a corresponding swelling affecting the right thumb, but there were no symptoms referable to this side.

The left thumb was operated upon on September 25, 1939; the sheath was split and a strip of sheath was removed from each side of the opening. The subcutaneous tissues were closed with plain catgut, and the skin with interrupted silk; a tongue-depressor splint was applied on the extensor surface of the thumb. The postoperative course was uneventful.

On May 21, 1941, examination showed a fixed deformity of the right thumb. The thumb was held flexed at 140 degrees. The right thumb was operated upon June 9, 1941. The postoperative course was uneventful, and she made a complete recovery.

Roentgenograms of both thumbs were negative prior to operation.

CASE 2. J. K., male, aged nineteen months, was first seen August 5, 1940, because of stiffness of the left thumb of a month's duration. There was no history of injury.

The thumb was held at 145 degrees, at the interphalangeal joint, and there was swelling over the flexor surface of the neck of the first metacarpal (Fig. 1).

There was a corresponding swelling on the flexor surface of the right thumb, but no symptoms have developed.

On June 10, 1941, the left thumb was operated upon through a transverse incision in the palmar crease. The postoperative course was uneventful, and he made a complete recovery.

The only treatment of value is operative. Splitting of the affected tendon sheath is all that is necessary, though the author removes a small segment in the longitudinal axis of the sheath for microscopic study. At operation, the constriction is found in the sheath of the flexor pollicis longus at the first metacarpophalangeal joint. The sheath is opened for a distance of one-half to three-quarters of an inch, and a probe or small grooved director is passed distally to the attachment of the tendon to the terminal phalanx and proximally for a corresponding distance, so that one may be sure that no constriction remains. The involvement may present itself simply as granulation tissue or it may be in the form of an encircling ring of fibrocartilaginous material. The tendon is found materially thickened proximal to the point of constriction. The involved area is best exposed through a transverse incision, following the crease on the flexor surface of the thumb, as this avoids any obvious scar. Only the subcutaneous tissues and the skin are closed,—the sheath itself being left open. A splint should be applied on the extensor surface of the thumb. Trauma probably plays little part in this condition in infants, and it is the author's opinion that the anomaly is of congenital origin.

CONCLUSION

Stenosing tenovaginitis of the thumb in infants involves the flexor pollicis longus and presents itself as a fixed flexion deformity of the interphalangeal joint. Unless one is familiar with the condition, it may be considered a dislocation at the interphalangeal joint. The results of splitting the narrowed sheath are uniformly good and this is the only treatment of value.

EXTENSION DEFORMITIES OF THE CERVICAL SPINE *

BY LLOYD T. BROWN, M.D., AND JOHN G. KUHN, M.D.,
BOSTON, MASSACHUSETTS

The object of this paper is to show that extension deformities of the cervical spine and other remote factors can cause the symptoms found in the so-called scalenus syndrome and in cervical ribs; also, that the distribution of the symptoms will depend, among other factors, upon the location of the habitual position of extreme extension of the cervical spine. If the apex of the curve is in the upper cervical region, the distribution will be through the cervical nerve plexus; and, if in the lower cervical spine, the distribution will be through the brachial plexus (Figs. 1-A and 1-B).

Aynesworth describes the scalenus and cervical-rib syndrome in the inclusive term cervical-brachial syndrome and divides the cases into three groups: (1) those which exhibit neurological symptoms as their chief manifestation; (2) those which exhibit vascular symptoms as their major manifestation; and (3) those which exhibit a combination of vascular and neurological symptoms. This suggests the probability that there must be causes more widespread and remote than the usual explanation of local pressure from a thickened scalenus anterior or a cervical rib.

In about 80 per cent. of the cases the contributing cause of the symptoms has been judged to be trauma, combined with the many other pathological conditions confined to the area of the neck. These pathological conditions are due to abnormal function in a few anatomical structures,—the muscles in this region, the cervical vertebrae, cervical ribs, abnormal first ribs, the clavicle, the cervical nerve trunks, the subclavian artery and vein, and the sympathetic and vasomotor nerves.

To the writers, an extension deformity is a relatively fixed position of the joints, muscles, and ligaments, from which, if further motion is made increasing the deformity, strain or injury will occur. If the spine is in a position of full extension, further extension will cause injury, usually at the position of greatest extension or at some compensatory point. The amount of injury will depend on the anatomical structure of the injured part and its habitual position of use, combined with the habitual position of use and the anatomical structure of the rest of the body.

Only the anatomy of the cervical spine will be taken up, but an understanding of the anatomy of the rest of the body, both structural and functional, is equally important for a proper understanding of the whole picture. It is not necessary to describe in detail all the cervical vertebrae. There are certain points, however, that must be considered: (1) the bones, (2) the ligaments, (3) the muscles, (4) the nerves, and (5) the effect on these of faulty mechanical use.

* Read at the Annual Meeting of The American Orthopaedic Association, Toronto, Ontario, June 12, 1941.



FIG. 1-A

Roentgenograms of cervical spine showing extension deformities in the upper and lower cervical regions. Such deformities are dependent on, or are compensatory to, deformities elsewhere in the spine.



FIG. 1-B

Roentgenograms of cervical spine showing extension deformities in the upper and lower cervical regions. Such deformities are dependent on, or are compensatory to, deformities elsewhere in the spine.

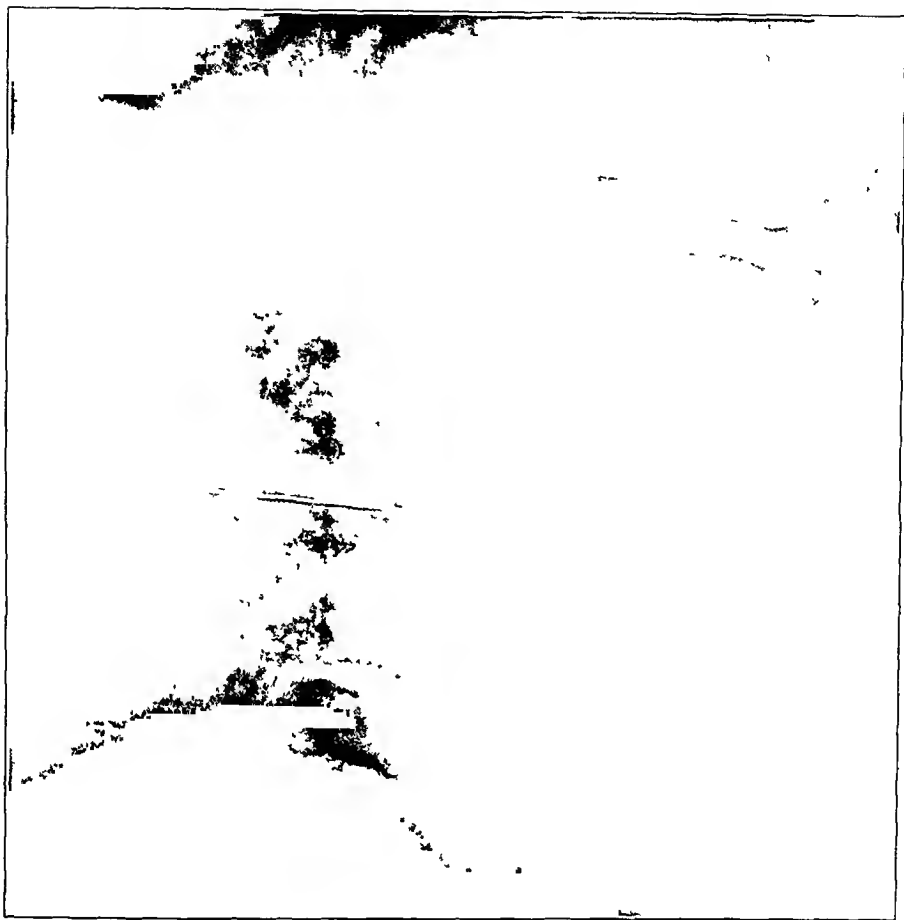


FIG. 2

Roentgenogram of the cervical spine, showing variations in the relation of the body of the vertebra to the spinous processes. A line drawn parallel to the lower surface of the body of the vertebra is either at the level of the inferior border or crosses over the spinous process.

In a case of long-standing faulty body mechanics, a similar line will not only be above the spinous process, but may cross the spinous process of the first or second vertebra above (See Fig. 10-A). This makes a much more acute angle between the pedicles and the body, and narrows the space between the body and the vertebral arches, thus limiting the factor of safety that is normally present.

Bones

Variations occur in the shape of the vertebral bodies themselves. These may be congenital in origin or may develop from unusual stresses during the growing period. One of these variations is in the relation of the bodies of the vertebrae to their spinous processes. In some, a line drawn along the under surface of the body and extended backward just touches the inferior surface of, or crosses over, the spinous process (Fig. 2). In others a similar line will cross over the spinous process of the first or second vertebra above (Fig. 10-A). It has been found that this latter condition occurs in the presence of long-standing faulty body mechanics. Such a condition means a decrease in the angle between the vertebral body and the pedicles, and a consequent narrowing of the space in this region.

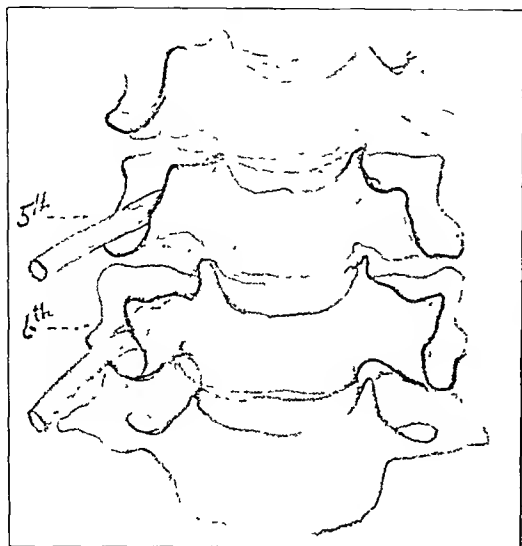


FIG. 3

Drawing of the cervical vertebrae showing the transverse processes and the grooves in which lie the nerves. Muscles and ligaments are also attached to the sides of the grooves.

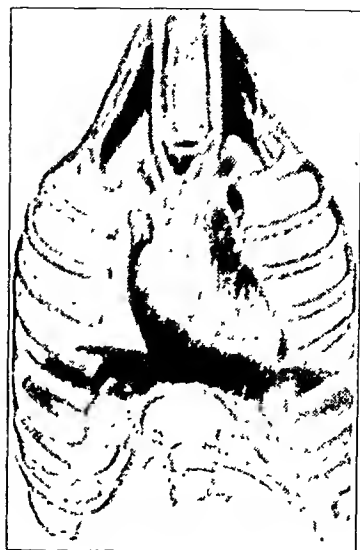


FIG. 4

Drawing showing the prolongations of the cervical fascia to the heart and diaphragm, as the suspensory ligament of the diaphragm. Note also the scaleni.

This increases the possibility of crowding the structures here, especially when combined with other abnormalities,—such as the result of hypertrophic arthritis, or of trauma.

Intervertebral Foramina

When the cervical spine is flexed forward, the size of the intervertebral foramina is greater than when it is at full extension. In full extension the articular facets of the vertebra below push up into the foramina, thus making them smaller. If there are hypertrophic or other inflammatory changes encroaching on the lumina, this position of extension will make the foramina smaller and there will be greater chance for irritation of the structures within the foramina,—that is, arteries, veins, and nerves.

Transverse Processes

The transverse processes of the cervical spine are so formed that they carry the nerve roots in a groove of varying depth, and thus protect them from possible injury as they emerge from the spinal canal and foramina of this freely movable part of the spine. This groove is like a U and the two free ends of the U represent the tubercles of the transverse processes. It is to these free ends of the U that many of the important muscles and ligaments are attached (Fig. 3).

Ligaments

Some of the ligaments which are attached to the tubercles of the transverse processes are the intertransverse ligaments and those which

connect the transverse processes to the vertebral bodies above and below. From the point of view of this paper, more important than these are the attachments of the deep cervical fascia to the tubercles. The deep cervical fascia is prolonged downward (Fig. 4) to spread over the muscles of the chest wall and the pericardium to the diaphragm. In faulty body mechanics the diaphragm is abnormally pulled downward by the weight of the abdominal organs and by the chest wall itself, thereby causing strain on all the structures in the neck. It is this abnormal pull of the weight of these structures on the neck that may explain some of the symptoms which are referred to the arm and the thorax, as well as the hypertrophies of the scaleni and tubercles.

Muscles

There are also attached to each free arm of the U the anterior and posterior tubercles of the transverse processes, the very important scaleni (Fig. 5). The scalenus anterior is attached to the anterior tubercles, and the large median and posterior scaleni to the posterior tubercles. The nerve roots come out between these muscles, as well as between the ligamentous attachments. The phrenic nerve, as it comes up from the diaphragm and thorax, becomes imbedded in the body of the scalenus medius before it joins the nerve root at the fourth or fifth cervical vertebra. These muscles, being inserted into the first and second ribs, are stretched and pulled downward in faulty body mechanics and in the associated extension deformity of the cervical spine, when the chest and diaphragm have drooped and sagged.

Other muscles which are attached to the tubercles of the transverse processes are the longus colli, the longus capitis, the multifidus and semispinales and the intertransversarii. The intertransversarii consist of seven pairs of small fleshy strips on each side, which connect the bifid extremities of the transverse processes. The anterior slip of each pair is attached to the anterior tubercles of two adjacent processes, while the posterior slips extend between the posterior tubercles. The highest pair of muscular slips lie between the atlas and the axis, and the lowest pair connect the seventh cervical vertebra to the transverse process of the first thoracic vertebra. The spinal nerves have a very definite relation to the intertransversarii. The anterior primary branches of the lower six cervical nerves pass outward between the two slips of the corresponding muscles. The posterior primary divisions of the same nerves turn backward behind the slips. All of these muscles can be affected by long-standing strains from extension deformity of the cervical spine and its associated faulty body mechanics.

Ribs

The normal first rib comes away from the spine at a slightly downward inclination, articulates with the transverse process, and continues around to the sternum with no distortion of the shaft in relation to the

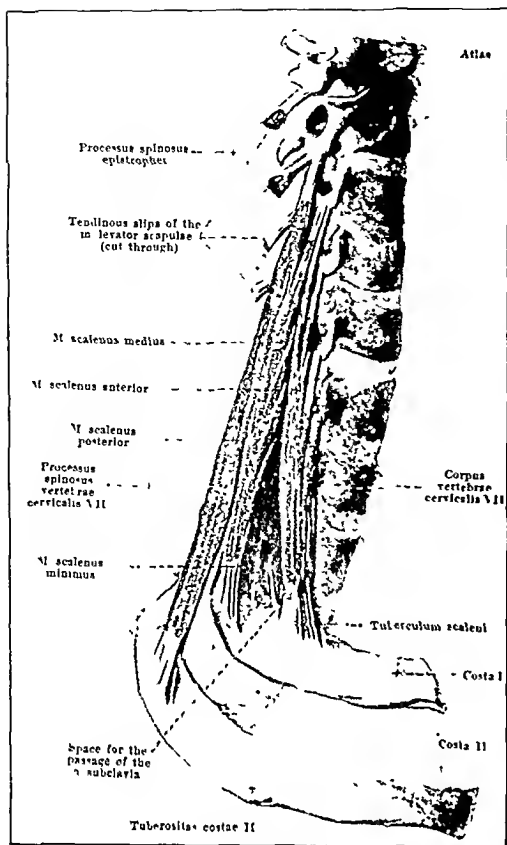


FIG. 5

Showing the origin of the scaleni from the tubercles of the transverse processes and their insertions into the first and second ribs. From this can be seen the possibilities of the combination of an extension deformity of the cervical spine and the downward pull of the chest and abdominal organs. (*Reproduced by courtesy of J. B. Lippincott and Company.*²)

are present also abnormalities—such as long transverse processes of the seventh cervical vertebra, cervical ribs, abnormal first ribs and clavicles, abnormally large scaleni, abnormal brachial plexus, or abnormalities of the sympathetic nerves or subclavian arteries or veins—the possibility of symptoms is much greater, especially in the presence of strain or injury in this region.

The motions of the cervical spine, or injuries in this region, vary according to the habitual position of use. With the cervical spine in the best mechanical position for function, and with the curve not exaggerated, rotation takes place largely in the upper two cervical vertebrae. There is very little lateral motion here. In the lower vertebrae, the third to the seventh, there is very little rotation and much more lateral motion. However, when the cervical spine is in the position of extreme extension, as is present in habitual faulty body mechanics, all of these motions are much limited and in long-standing cases they will be accompanied by

neck of the rib (Fig. 6-A). In faulty body mechanics the first rib, after it leaves the transverse process, is almost vertical to the ground, and the shaft rotates downward and forward, so that the shaft of the ribs is distorted in its relation to the neck. This can be seen in an anteroposterior roentgenogram (Fig. 7-B). In this position the sternum and the structures attached to it are closer to the front of the spine, and the chest as a whole has changed its shape (Fig. 6-B).

In faulty body mechanics of long standing, with the first rib rotated downward and forward, the sternum will be almost vertical instead of projecting obliquely forward (Fig. 8). This vertical position of the sternum and the drooped first rib mean a pull upon, and crowding of, the structures entering the thorax. With such a condition, it is easy to understand why, with advancing years and increasing faulty body mechanics, the potential of injury to the cervical and brachial plexus becomes greater. If there

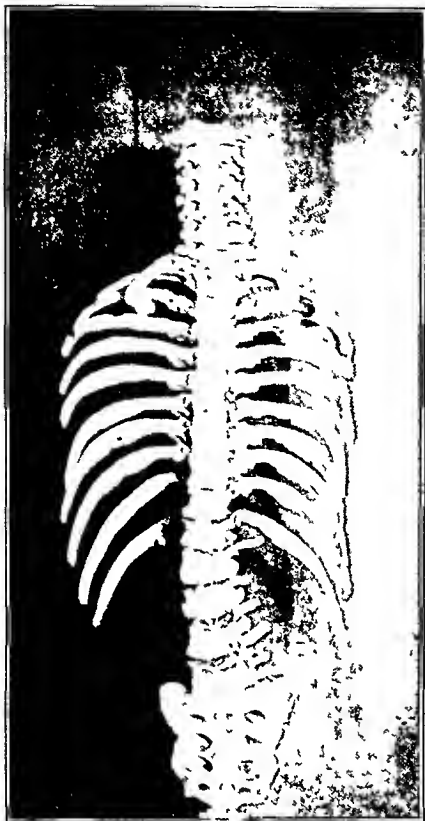


FIG. 6-A

Good body mechanics. Note that the first rib comes away from the spine, articulates with the transverse process and continues around to the sternum at a slightly oblique angle, without distortion of the shaft in relation to the neck of the rib.

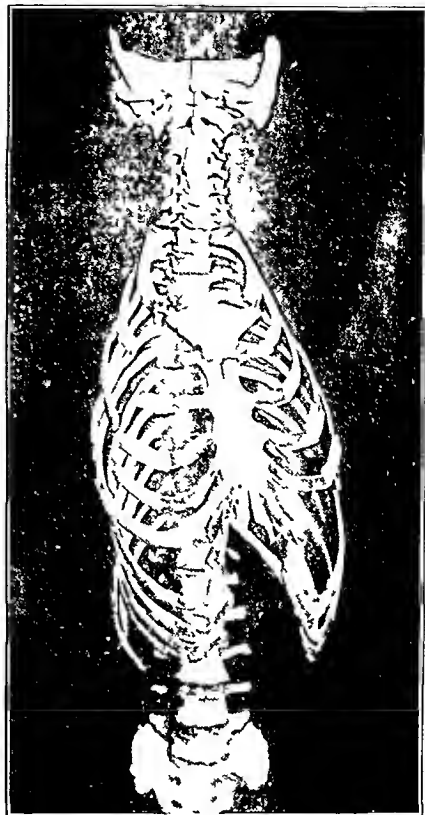


FIG. 6-B

Faulty body mechanics. After the first rib leaves the transverse process, the shaft rotates downward in its relation to the neck of this rib, and it is almost vertical to the ground.

considerable crepitation. This limitation of motion can be demonstrated by having the patient lie on his back and flatten the cervical curve before trying out the motions. If the motion is not increased, one must suspect anatomical or pathological changes in the joints.

TREATMENT

The object of treatment is to correct the extension deformities in the cervical and lumbar regions of the spine, and also the flexion deformity of the thoracic spine and the associated drooped chest. The correction of the extension deformity of the cervical spine is most easily accomplished by recumbency on the back on a firm mattress. To relieve the strain on the lumbar spine, a large pillow under the knees and a small pillow to fill the hollow in the low back is helpful. With this procedure muscle spasm subsides quickly in most instances. The authors have rarely found head-traction necessary. A felt collar, fitted low in front and high in back, to reduce the extension deformity, adds to the patient's comfort

(Figs. 9-A and 9-B). The correction of the drooped chest and of the extension deformity of the lumbar spine is obtained gradually by exercises planned to correct the habitual faulty position of use. These are begun in recumbency, and progress to the sitting and standing positions, emphasis being laid upon good body mechanics rather than upon the exercises, *per se*. When the ambulatory stage is reached, support for the spine and abdomen is usually necessary.

It is the authors' belief, that when structural, anatomical, and functional abnormalities are present, they are the potential of symptoms which may be initiated with trauma, even though the trauma is relatively slight or is the result of long-standing strain. With this point of view, treatment is planned first to correct the remote causes rather than the local ones,—such as local muscular hypertrophies, or structural abnormalities. It will be found that these remote conditions, as well as the local ones, have been present for a long time before the trauma which started the symptoms occurred. If the remote mechanical causes are removed, in most instances the symptoms will be relieved.

Three patients will be described, in whom the correction of the extension deformity and of the faulty use of the cervical spine, as a part of the correction of the whole body, gave complete relief without any operative procedures, although the authors were ready to operate if necessary. The operative procedure will often give relief of the local symptoms, but it does nothing to correct either the deformities in the cervical spine or the remote causes elsewhere in the body.

CASE 1. This patient was a sixty-five-year-old male, who complained of progressive weakness and pain in the right hand, of three months' duration. The hand was continually cold and at times numb. There was a history of a severe twist of the spine several months before the onset of symptoms. Examination was negative except for the spine, and the right arm and hand. The right elbow was limited in extension to 145 degrees, the result of an injury fifty years before. There was an extension deformity of the cervical spine with accompanying faulty body mechanics which had been getting worse of late. Roentgenograms showed no cervical ribs and minimal hypertrophic arthritis in the cervical spine. The right hand was colder than the left. There was wasting of the muscles of the forearm, and of the thenar and hypothenar eminences and the interossei. There were transient attacks of hypo-aesthesia in the hand and forearm. The laboratory studies were all negative. A complete neurological examination in another clinic showed no evidence of scalenus anterior syndrome. Treatment consisted in correcting the extension deformity of the cervical spine and the faulty body mechan-

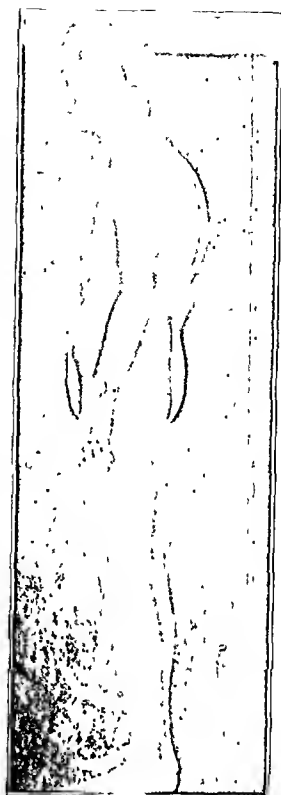


FIG. 8

Lateral view showing not only the vertical position of the sternum, but also the compensatory curves of the spine and other changes in the shape of the body. This patient had a very marked low-cervical extension deformity.



FIG. 9-A

Extension deformity of the cervical spine.



FIG. 9-B

Correction of extension deformity with felt cervical collar.

ics, chiefly by bed rest and exercises, followed by the wearing of a support for a number of months. After several months the patient's symptoms entirely disappeared. Four years later the patient reported that there were no symptoms, and there was complete disappearance of the atrophy.

CASE 2. This patient was a man of fifty-six years, who had always done hard physical work until ten years previously, when he began to work at a desk. For the past five months he had had constant pain in the right arm, with numbness and weakness in the entire right arm. Sitting in a barber chair with the neck hyperextended increased the pain in the right arm. Except for increasing obesity, there were no other symptoms. Examination showed a short, heavily built man with an increase in all of the curves of the spine. There was limitation in all movements in the cervical region. Pulling downward on the shoulder or arm did not increase the pain, nor was it decreased by raising the clavicle. There was a tender point at the junction of the middle and outer thirds of the clavicle. Roentgenograms showed no cervical ribs. There were extensive hypertrophic changes at the margins of the fourth, fifth, and sixth cervical vertebrae. Examination, including neurological examination, was otherwise negative. Treatment consisted of eighteen days' hospitalization with special positions and exercises designed to lessen the severity of the deformities of the spine and body. He was shown how to use the neck and body in good mechanics. Symptoms subsided more slowly in this patient. At the present time, almost five years since he was first seen, he has remained free of symptoms except when he becomes careless or fatigued. He has not changed the osseous deformity, but he has corrected in part the old habitual position of the cervical spine, and has thereby lessened the tendency to these symptoms (Figs. 10-A and 10-B).

CASE 3. A woman, thirty-five years old, complained of pain and swelling in the left hand and forearm. Examination showed a short, plump woman with swelling of the entire left hand, extending slightly above the wrist. The hand was tender throughout. Physical and laboratory examination showed no definite evidence of arthritis. Roentgenograms of the cervical spine showed a cervical rib on the right side, but no abnormality



FIG. 10-B

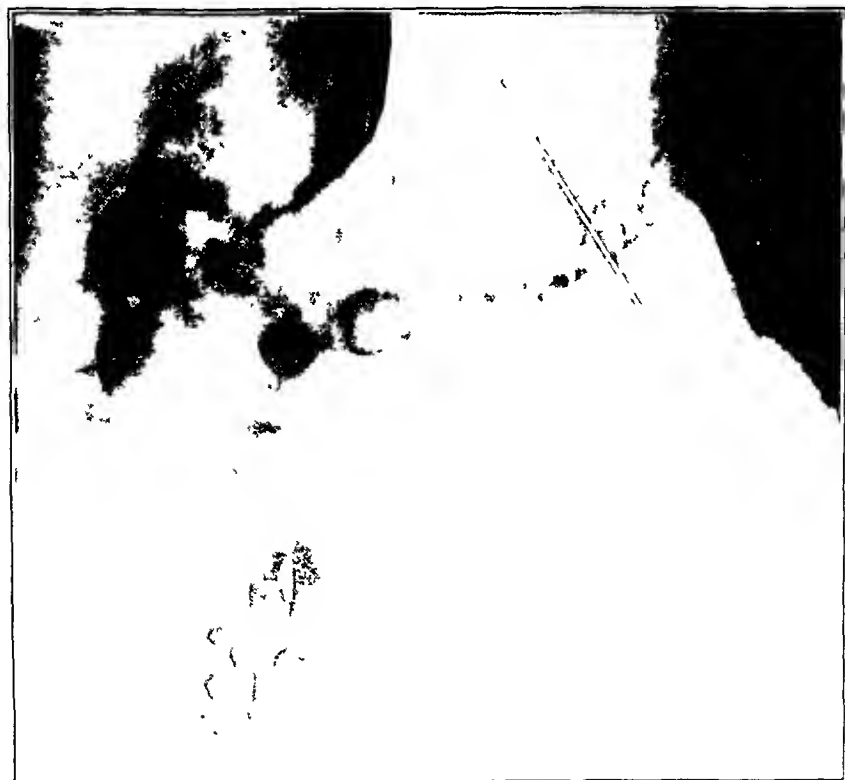


FIG. 10-A

Case 2. Roentgenograms show the extreme extension in the lower cervical spine, and the amount of correction obtained after treatment.

on the left side. Neurological consultation revealed no evidence of scalenus anterior syndrome. Treatment consisted in decreasing the extension of the cervical curve and in correcting the faulty body mechanics. Swelling disappeared in two months and the symptoms have not recurred during the past three years.

As these cases show, there are patients, with symptomatology which suggests a cervical rib or a contracted scalenus anterior, whose symptoms are the result of neurological or vascular irritation from an extension deformity of the cervical spine. When structural or functional abnormalities are present in the cervical region, they are the potential of symptoms which may be initiated by slight trauma when the cervical spine is habitually used in extreme extension. When the extension deformity and the faulty body mechanics are corrected, symptoms will often be relieved. Occasionally operative treatment may be required.

CONCLUSIONS

The symptoms commonly found in the so-called scalenus syndrome, or with cervical ribs, may be caused by remote factors as well as local ones. These symptoms are frequently due to trauma, either from a definite strain or from the chronic strains which come in the use of the whole body, and especially of the chest and cervical spine, for a long period of time in faulty mechanics, combined with general relaxation and fatigue. In the authors' experience, the correction of the extension deformity of the cervical spine, combined with the correction of the faulty use of the body as a whole, will bring relief of the neurological as well as of the vascular symptoms, in the majority of cases, without the necessity of operative procedures.

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TUBERCULOSIS OF THE FLAT BONES OF THE VAULT OF THE SKULL

A STUDY OF FORTY CASES

BY C. M. MENG, M.D., AND Y. K. WU, M.B., CH.B., PEIPING, CHINA

*From the Division of Orthopaedic Surgery, Department of Surgery,
Peiping Union Medical College*

Tuberculosis of the skull has been considered a relatively rare disease, and the literature of the last two decades contains little mention of it; but in those parts of the world in which tuberculosis is still prevalent this impression is scarcely valid. The incidence of tuberculosis in a given community provides a fairly accurate index of the social and economic standards of the population. Where these levels are low the disease flourishes; and where they are as low and the general morbidity of tuberculosis is as high as is the case in China, lesions of the osseous system are common. Under such circumstances it would be illogical to presume that the flat bones of the skull would escape infection. The authors' experience at the Peiping Union Medical College Hospital gives support to this contention.

According to Straus, the first authentic case of tuberculosis of the skull was reported in 1842. Thirty-eight years later, Volkmann published a valuable clinicopathological study of thirty-one cases previously reported and twelve of his own. Subsequently, in 1910, Pelletier collected 206 cases. Only a few cases were added during the next two decades. Straus, in 1933, assembled from the world literature 220 cases and added three of his own. Nakajima recently reported four cases and found only three cases previously described in the Japanese literature. At the Peiping Union Medical College Hospital, tuberculosis of the skull not infrequently has been seen. During a period of fifteen years (1926 to 1940 inclusive) more than seventy cases were

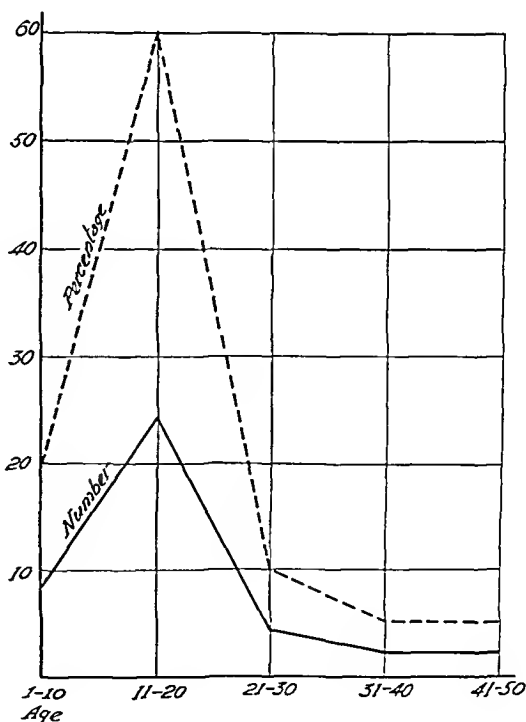


FIG. 1

The frequency of tuberculosis of the skull during various age periods.

diagnosed clinically. Among this number sufficient data to establish definitely the diagnosis were obtained in forty cases. These cases constitute the basis of the present study.

In twenty of the forty cases the diagnosis was established histologically; in five cases it was established by animal inoculation or by culture; and in the remaining fifteen cases the clinical, roentgenographic, and other laboratory findings were such that the diagnosis of tuberculosis seemed justified.

ETIOLOGICAL FACTORS

Sex and Age

Both sexes are affected, and in this series of cases the male patients slightly outnumbered the female; of the forty patients, twenty-three were male and seventeen were female. There was a marked difference in the frequency of the disease among the various age groups; 80 per cent. of the patients were less than twenty years of age (Fig. 1). Nevertheless, this disease is rarely observed in early infancy or after middle age, although one patient aged seven weeks and another seventy-three years of age have been recorded.

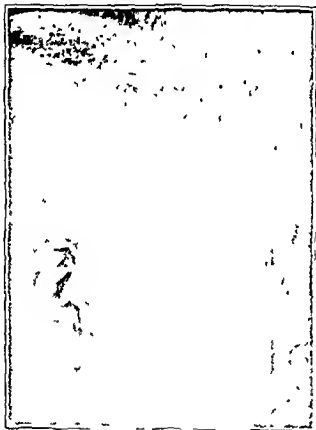


FIG. 2

Photograph of patient (H-72692), aged fifteen, showing an abscess of the right frontal region. Roentgenographic examination of the skull revealed no lesion, but at operation superficial erosion of the frontal bone was found. Pathological study of the tissue revealed tuberculosis. The patient also had tuberculosis of the cervical lymph nodes.

Trauma

Trauma has been considered an important factor in the development of lesions of the skull, in the sense that it may lessen tissue resistance and thereby favor localization of the tubercle bacilli, or in that it may aggravate or bring to light a lesion which has been latent up to that time. In the present series of cases, one patient only gave a history of direct injury to the head. In this instance the injury was sustained one week prior to the onset of a swelling (Fig. 2), which was said to have appeared and disappeared a number of times in the beginning, and to have become persistent only after a period of two years. Even after the lapse of this time, the lesion could not be demonstrated in roentgenograms, and only superficial erosion of the bone was observed at operation. The authors are inclined to believe that while trauma may be contributory, it is not an important or an essential factor.

Associated Tuberculous Lesions

The finding of tuberculous lesions in other parts of the body in patients suffering from tuberculosis of the skull is common. Among the forty patients in this series, such lesions were present in 85 per cent.

TABLE I
ASSOCIATED TUBERCULOUS LESIONS IN THIRTY-FOUR PATIENTS

Chest		22
Lung	18	
Pleura	3	
Pericardium	1	
Bone and joint		77
Facial bones	9	
Thorax	18	
Spine and pelvis	10	
Extremities	40	
Lymph nodes		6
Cervical	5	
Axillary	1	
Abdomen		5
Peritoneum	3	
Intestine	2	
Skin	4
Total number of associated lesions		114

Eleven patients had a single associated lesion and twenty-three patients had multiple lesions numbering from two to fifteen per patient. In six patients associated tuberculous lesions were not found. Four of these patients, however, were seen in the Out-Patient Clinic, where complete examinations were not made. In twenty-eight patients of whom roentgenograms of the chest were taken, pulmonary lesions compatible with tuberculosis of varying extent and activity were revealed in sixteen. A clinical diagnosis of pulmonary tuberculosis without roentgenographic confirmation was made in two other patients. Excluding the four cases in which incomplete examinations were carried out, pulmonary tuberculosis was found to be present in eighteen, or 50 per cent.

Bone and joint tuberculosis was found in twenty-seven patients and formed the majority of the associated lesions (Table 1). It was of special interest to note that in patients with multiple lesions of bone, all of these lesions not infrequently appeared within a short space of time. This observation concerned particularly those patients showing lesions of the facial bones. In six of the nine patients with lesions of the mandible or other facial bones, the lesions of the skull appeared more or less simultaneously with the facial lesions. The frequent observation in this series of the coexistence of lesions of the flat bones other than those of the skull is another interesting fact. Among the forty patients, the facial bones were involved in nine instances, the sternum in five, the scapula in four, and the pelvic bones in three. Since tuberculosis of the flat bones is relatively uncommon, this frequent coexistence of lesions in more than one flat bone might suggest that only a certain strain of tubercle bacilli is able to flourish in the scanty cancellous tissue of these bones. According to

Wegemer, Lange has suggested the bovine type of tubercle bacillus as the offending organism. The authors have good reason, however, to doubt that this particular organism was the causative agent in their cases, and are

more inclined to believe that the sudden appearance of multiple lesions is an indication of a breakdown of the general resistance of the patient.

PATHOLOGY

Pathogenesis

Tuberculosis of the skull as a primary lesion must be exceedingly rare, although Koenig estimated that one-fifth of all cases were primary, and Straus considered that cases of primary tuberculosis of the skull are not at all uncommon. The authors believe that this lesion is practically always secondary to a focus elsewhere in the body. The detection of the primary focus may be difficult, and the degree of success depends upon the thoroughness of the search. Failure to find it makes the lesion of the skull only apparently primary. Occasionally the skull may be involved as a result of the direct extension of a neighboring tuberculous lesion (as from the mastoid or the orbit), but lesions of this type have not been included in this study.

It is generally believed that when the disease is blood borne, it attacks the diploe first and then extends to involve the inner and outer tables. Which of the tables is involved first is still a controversial point. In one

patient, there was no external evidence of disease of the skull before death, but on postmortem examination two isolated lesions were found. One of them involved both tables and the other the inner table only (Fig. 3). In another patient, postmortem examination revealed, in addition to a known lesion with draining sinus involving both tables, a second lesion involving only the inner table (Fig. 4). However, the question of whether one or the other table is first involved is of more academic than practical importance. In most cases, by the time the disease has become manifest, both tables of the skull have been invaded. Occasionally the lesion starts from the periosteum, as is definitely illustrated by two of the cases. The dis-



FIG. 3

W. Y. S. (H-27346), a male, forty-one years old, died of extensive tuberculosis involving the lungs, intestines, liver, spleen, mesenteric and bronchial lymph nodes, and skull. One lesion of the skull involved both tables and the other the inner table only. The Wassermann reaction of the blood was strongly positive. The lesion involving the inner table of the skull is shown here. Note the scarred appearance of the external surface of the dura. The cerebral surface of the dura was not involved.



FIG. 4

W. K. C. (H-19660), a male, twenty-nine years old, died of extensive tuberculosis involving the lungs, skin, scapula, elbow, sternum, intestines, axillary and mesenteric lymph nodes, and skull. The Wassermann reaction of the blood was positive.

A: Roentgenogram showing the location of the lesions, the thickening of the skull, and the increased density of the bone.

B: Photograph of the inner table of the skull. Note the size of the sequestrum in the upper lesion.

C: Exterior view. Note the size of the defect in the outer table as compared to that of the sequestrum. The lower lesion involved the inner table only.

ease also may start from the dura and secondarily involve the skull, although no such case was observed in the present series.

Pathological Types

1. The circumscribed (perforating) type of lesion described by Volkmann presents one or more well-circumscribed areas of destruction, involving at first one table, and having a tendency to perforate the entire thickness of the bone. A well-formed sequestrum, corresponding to the shape of the defect, is commonly seen (Figs. 4 A and 4 B), but bone sand also has been observed to fill the defects. In those cases in which the lesion seems to have originated from the inner table, it is not unusual to find the sequestrum larger than the opening in the outer table (Figs. 4 B and 4 C). In the present series of forty cases, all except two belong to this type as is evidenced by the roentgenographic, operative, or postmortem findings. In about half of them, the defects were round or oval with well-defined outline, and varied from a few millimeters to two centimeters in diameter. In the other cases the defects were irregular with ill-defined edges. Occasionally two closely situated, well-circumscribed lesions had become confluent (Fig. 5).

2. In the diffuse (infiltrating) type of lesion described by Koenig, the disease starts in the diploe, spreads through the latter structure progressively, and involves the compact tables as it extends, causing multiple perforations. Clinically this type of lesion is believed to occur more commonly in children. Lenormant and Soupault, on the basis of the findings in one of their cases, suggested that the extension of the dis-



FIG. 5

S. H. M. (O.P.D. 450957), a male, twenty-five years old, had tuberculosis of the sternum, fibula, spine, foot, lungs, and skull. This roentgenogram of the skull shows multiple circumscribed lesions and the presence of sequestria. Note particularly the absence of bone reaction around the lesions, and the two adjacent lesions which have become confluent.



FIG. 6

W. H. C. (O.P.D. 423790), a girl, fourteen years of age, had a swelling over the parietal region for two years, with later rupture and the formation of a large ulcerative pulsating lesion. The Wassermann reaction of the blood was negative. The roentgenogram showed an extensive, diffuse lesion of the parietal bone. The clinical diagnosis was tuberculosis, but the roentgenographic diagnosis was syphilis. Tuberculosis was demonstrated histologically only after biopsy had been performed on four occasions.

case process is not through the diploe, but through a layer of tuberculous granulation which forms between the inner table and the dura (beginning from the primary site of perforation), and subsequently invades the bone at multiple points. St. John contended that the circumscribed and the diffuse types are but two different stages of development of a



FIG. 7

S. C. Y. (O.P.D. 451803), a girl, fifteen years old, complained of having ulcerative, pulsating, discharging lesions over the parietal region for more than two years. There also were lesions characteristic of tuberculosis in the lungs, ribs, and spine. The Wassermann reaction of the blood was negative. Biopsy of the lesions of the skull revealed tuberculosis.

A shows extent of the diffuse lesions.

B shows the external appearance of the lesions.

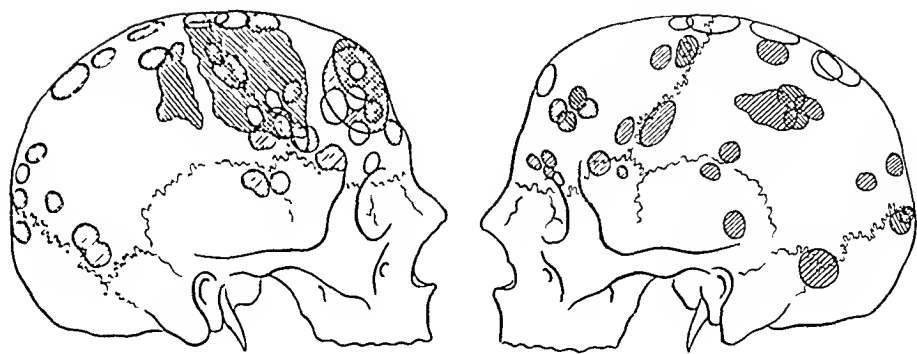


FIG. 8

Topographic distribution of the lesions in thirty-nine cases. The shaded areas are proved lesions and the unshaded areas probable lesions. One large lesion, involving practically the entire left parietal bone (in another case) is separately illustrated in Fig. 6.

common lesion, and considered that multiple perforations of the skull are only the external representations of a single focus in the bone. In the present series, two cases were of the diffuse type (Figs. 6 and 7).

In either type of lesion, as the disease perforates the outer table of the skull, a subperiosteal abscess is formed. This abscess may remain as a small, palpable, firm, non-tender mass for some time. Subsequently it may rupture through the periosteum and form a softer mass in the subcutaneous tissues; eventually it will find its way to the exterior with the formation of a chronic discharging sinus. The location of the abscess and the sinus corresponds closely to the underlying lesion in the bone. Occasionally, however, the abscess may gravitate to a lower level, and the sinus may be found a short distance away from the actual site of the lesion of the bone.

When the inner table is perforated, the underlying dura may be thickened and covered by caseous material or granulation tissue. The cerebral surface of the dura, however, appears normal. Furthermore the dura frequently is observed to be adherent to the edges of the bony defect. These observations tend to refute the theory of Lenormant and Soupault regarding the mode of extension of the diffuse, infiltrating type of lesion along a layer of granulation tissue formed between the dura and the inner table; they also may account for the rare development of cerebromeningeal symptoms in tuberculosis of the skull. Only ten cases of tuberculous meningitis and five cases of cerebral tuberculosis were observed in 223 cases collected by Straus. This complication was not observed in the authors' cases.

Number and Location of the Lesions

A single lesion (including the diffuse type) was present in twenty-three of the forty cases, and multiple lesions varying in number from two to four were observed in the remaining seventeen cases. The location of the lesions was determined by roentgenographic examination, by autopsy,

and by operation. In cases a single lesion involved two adjacent bones, crossing the suture in each instance; in another case the lesion occurred at the junction of three bones. Several of these patients were less than twenty years of age. It was evident that the suture did not form a barrier to the spread of the disease. The sites of these lesions are illustrated topographically in Figure 8. The frontal and parietal bones were most frequently affected, and both sides of the skull were fairly evenly involved. That the lesions are mostly situated in the frontal and parietal bones usually finds explanation in the fact that these bones are more exposed to trauma. From observation of cross-sections of the various bones of the skull, it is the authors' belief that the frequent involvement of these two bones is due to the comparatively greater amount of cancellous bone and diploic structures present in them.

CLINICAL MANIFESTATIONS

The onset invariably is insidious. Many of the patients came to seek treatment for lesions of other parts of the body, and the lesion of the skull was discovered on physical examination. The first local manifestation is the development of a swelling. It usually is not painful unless complicated by secondary infection. At first it is small, firm, and fixed to the skull, but gradually it increases in size and softens, to form a fluctuating cold abscess which shows little or no tenderness. It not infrequently is mistaken for a sebaceous cyst or lipoma. Pulsation of the swelling, synchronous with the radial pulse, may indicate perforation of both tables of the skull. When secondarily infected, the lesion may not be easily distinguishable from an ordinary pyogenic abscess, and for such it not infrequently is incised and drained. A typical chronic tuberculous ulcer or draining sinus (Fig. 7B) eventually forms after either spontaneous rupture or surgical incision of the swelling. If the whole thickness of the skull is eroded over a large area, pulsation of the dura may be clearly visible at the bottom of the wound. Occasionally a small area of alopecia around the ulcer may be present.

Among the forty patients, cold abscesses were present in eighteen; these abscesses were single in fifteen instances and multiple in three. The diameter of the abscesses ranged from one to seven centimeters. A definite bone defect could be felt around the base of the abscess in several instances. In twenty patients a draining sinus or sinuses were present. One patient had both a cold abscess and a draining sinus, and in another patient, who died of active pulmonary tuberculosis, there was no evidence of disease of the skull externally, and the lesion was discovered only on postmortem examination.

Symptoms referable to involvement of the meninges or the cerebral cortex, although mentioned by other authors, were not observed in the present series. It may be worthy of note that most of the patients remained afebrile and in fair general nutritional condition, except for a few who harbored active pulmonary or intestinal lesions.

DIAGNOSIS

In the absence of a swelling or a discharging sinus, the patient rarely has any complaint suggestive of this disease, and hence an early diagnosis is infrequent. In a tuberculous individual, especially a child or an adolescent, great care should be exercised to palpate carefully the bones of the head. When a swelling or a sinus is present, in addition to other tuberculous lesions, especially of the bones of the face, the diagnosis of tuberculosis of the skull should be considered until disproved.

Tuberculin Test: In children a positive tuberculin test affords additional evidence to support the diagnosis. A negative result following repeated tests is of far more value in ruling out the disease. In the present series, tuberculin tests were carried out in six patients below the age of twelve years, and all gave strongly positive reactions.

Blood Wassermann Reaction: Differential diagnosis between tuberculosis and syphilis of the skull is frequently difficult, particularly in adults, and for this reason a sample of blood always should be taken for serological tests. In the present series, Wassermann and Kahn tests were performed in all but four cases. In those instances in which there was clinical or roentgenographic suspicion of syphilis, the tests were repeated. Positive tests were obtained in only three patients. It happened that one of these three patients, who had been thought to have syphilis of the skull by both the syphilologist and the roentgenologist, was found on postmortem examination to have tuberculosis instead (Fig. 4). A second patient with a positive Wassermann reaction had multiple lesions involving the skull, mandible, phalanges of the feet, rib, and lungs. Tuberculosis was found in the skull, phalanges, and rib, from which tissue was removed. A positive Wassermann reaction, therefore, does not necessarily exclude the diagnosis of tuberculosis of the skull.

Roentgenography: Although roentgenography is an important aid in the diagnosis of lesions of the skull, it occasionally fails to disclose early, superficial, periosteal tuberculous lesions. Contrariwise, the visualization of actual lesions by roentgenograms does not necessarily mean that they are tuberculous. The findings often are so varied and confusing that an incorrect diagnosis can easily be made. In many instances, therefore, it is im-



FIG. 9

W. S. C. (O.P.D. 444004), a male, eighteen years of age, complained of having an abscess of the forehead for more than five months. Physical examination revealed lesions suggestive of tuberculosis of the pelvic bones, right shoulder, peritoneum, and sternum. The Wassermann reaction of the blood was negative. Tubercle bacilli were found in pus aspirated from the abscess of the head. In the roentgenogram can be seen a perforated lesion of the frontal bone surrounded by a thick zone of increased density. Compare with Fig. 5.



FIG. 10

C. Y. C (O.P.D. 94126), a Chinese male, aged forty-eight years, had multiple sinuses of the scalp for more than two years, and a fusiform swelling of the right elbow for more than one year. These lesions were thought to be syphilitic. The blood Wassermann reaction was negative on four different occasions. Because of the previous history of multiple venereal exposures, antiluetic treatment was given and continued for ten weeks without improvement. The condition of the elbow became worse and finally was proved to be tuberculous by animal inoculation. The lesion of the skull probably was tuberculous also; its roentgenographic appearance evidently was modified by secondary infection.

lesion, which shows little evidence of osteoplastic repair. Occasionally, however, exuberant osteogenesis may be observed along with osteolytic changes in cases in which multiple discharging sinuses or ulcerative wounds of the scalp are present. Diagnosis in these cases is often extremely difficult, and, if in addition, a positive Wassermann reaction or a previous luetic history is present, one may easily be led astray (Figs. 4 and 10). As mentioned previously, the majority of tuberculous lesions of the skull are represented by well-defined round defects, usually not larger than two centimeters in diameter. Still in some cases the lesions appear irregular in shape, less distinct in outline, and of fairly large size. It may be added that, in order to localize the lesions accurately, it is often necessary to take roentgenograms of the skull from various positions.

Aspiration: Unless contra-indicated, this procedure is of distinct diagnostic value. In a tuberculous abscess, the pus frequently contains caseous material. It is seldom possible to find tubercle bacilli in the pus on ordinary smear examination. However, the organism can frequently be demonstrated by culture or by animal inoculation. In this series, culture was employed four times, with positive results in three cases. Animal inoculation was carried out in three cases, and a positive result was obtained in each instance. In one of these latter cases a positive culture also was present.

perative for the roentgenologist to know at least the essential facts of the clinical record, and the nature of the associated lesions, if any are present. The usual roentgenographic picture is that of one or more circumscribed, round or oval, punched-out bone defects, in which a definite sequestrum or bone sand may be observed, and about which there may be no reaction, or a zone of increased density extending from one to two centimeters peripherally (Fig. 9). Tuberculosis of the skull is predominantly a destructive

Biopsy: When there is an open ulcer or a sinus, a biopsy of the granulation tissue gives valuable information. The finding of characteristic tubercles and acid-fast bacilli in the tissue establishes the diagnosis. A single negative finding, however, does not exclude the disease, particularly when the sinus has been of long duration or is secondarily infected. Repeated attempts at biopsy are often necessary. In one of the cases, the diagnosis was established only after the fourth biopsy had been made. It is important that the specimen be taken from a relatively deep part of the sinus. In some cases an exploratory operation is necessary to establish the diagnosis. In the present series of forty cases, the diagnosis of tuberculosis was established in twenty by study of the tissue specimen.

DIFFERENTIAL DIAGNOSIS

A swelling of the scalp due to a tuberculous lesion of the skull may easily be mistaken for a lipoma, a sebaceous cyst, or, if it is secondarily infected, a pyogenic abscess. When an osseous defect is discovered in the roentgenogram, it is not uncommonly interpreted as of syphilitic origin. Tumors of the skull such as osteosarcoma, myeloma, endothelioma, and metastatic carcinoma occasionally may be confused with a tuberculous lesion. Under the title of "Tuberculosis and Polyuria", Hand, in 1893, described unknowingly the first case of xanthomatosis of the skull. It is needless to say that careful clinical investigation aided by various laboratory tests is essential in order to avoid error.

PROGNOSIS

The prognosis of patients with tuberculosis of the skull depends upon several factors: (1) the state of the general health; (2) the extent of the local lesion; and (3) incidentally, the early establishment of a correct diagnosis. When the patient is seen at an advanced stage of the disease, with associated active pulmonary or intestinal lesions, the condition usually is hopeless. On the other hand, if the patient is seen early and the general health is good, even in the presence of multiple associated lesions, the prognosis is still fair if the proper general and local treatment can be carried out. Locally, a single circumscribed lesion has a much better prognosis than is the case when multiple diffuse lesions are present. It is lamentable to record that so many of the authors' patients did not seek treatment until they presented a condition for which one hesitated to entertain any hope.

TREATMENT

The general well-being of the patient must be the first consideration, as much of the success of the local treatment depends upon the patient's general state of health. Therefore, adequate supportive measures must be provided for these patients just as for patients with tuberculous lesions elsewhere in the body.

Whenever possible, the local treatment consists in complete excision of the diseased tissues. The sequestrum usually can be picked out easily.

The diseased bone should be rongeured away until healthy bone is reached. In the perforating or circumscribed type of lesion, the dura, which usually is adherent around the defect, should not be disturbed. Following excision, the incision should be closed without drainage. The wound should be left open only when there has been a discharging sinus or an ulcer. A large bone defect resulting from the operation is undesirable and should be avoided if possible.

In the present series, operative treatment was carried out in only eight instances. All of the lesions were of the circumscribed type. In four cases the lesions had perforated the whole thickness of the skull,—in one had involved the outer table alone, and in the other three had involved only the superficial layer of the outer table. In four cases the wounds healed *per primam*. In the other four cases, in which sinuses had been present before the operation, the wounds healed from one to ten months later.

Experience gained in the treatment of these patients makes the authors feel that in well-selected cases, local excision yields satisfactory results, and should be practised more frequently. Occasionally high-voltage roentgen therapy may be employed locally. Such therapy was carried out in one of the cases as the only form of treatment, and in another two cases as postoperative treatment, with favorable response in all. This experience, together with observations of the effect of high voltage roentgen rays upon tuberculous lesions of other parts of the skeleton, leads to the belief that this type of therapy may be of help in certain cases in which local excision is impossible, or in which healing of the wound following operation is slow.

SUMMARY AND CONCLUSIONS

1. Forty cases of tuberculosis of the skull have been analyzed and the clinicopathological aspects of the disease discussed.

2. Tuberculosis of the skull is not rare in parts of the world where tuberculosis is prevalent. It is an affection predominantly of childhood and adolescence.

3. Tuberculosis of the skull is practically always secondary to an active or latent tuberculous lesion elsewhere in the body. It is frequently associated with pulmonary lesions and those of bones and joints. Not infrequently tuberculosis of other flat bones may coexist in the same individual.

4. The lesion usually is of the circumscribed type often represented clinically by a painless cold abscess or discharging sinus.

5. A correct diagnosis usually can be made if this condition is kept in mind, particularly if tuberculous lesions are found in other parts of the body. Occasionally, however, difficulty is encountered in differentiating tuberculosis from other destructive lesions, notably syphilis. Laboratory examinations following aspiration or biopsy have proved of much value and should be employed whenever possible.

6. Roentgenographic examination is helpful, but is not always reliable, and at times may be quite misleading.

7. A cure can be reasonably hoped for in selected cases, if local excision is carried out, but in the majority of cases the condition is so far advanced that treatment consists of simple local dressings. In a few cases high-voltage roentgen therapy has proved beneficial.

8. Whatever the local treatment may be, the fact should be appreciated, that patients with a tuberculous lesion of the skull are suffering from a tuberculous disease and, for this reason, require adequate general antituberculosis care.

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PELVIC FRACTURES AND DISLOCATIONS REDUCED BY TURNBUCKLES

BY HOWARD DUDGEON, JR., M.D., WACO, TEXAS

In describing the results obtained in reducing severe fractures and dislocations of the pelvis by the use of turnbuckles as described by Jahss, the author assumes that all other complications usually present in this type of injury have been cared for.

The only types of traction suitable for pelvic fractures, or dislocations with marked displacement, are compression medially or expansion laterally, depending upon the injury present. The only means by which this can be done successfully is the use of turnbuckles incorporated in plaster. The only material needed for making this apparatus is five six-inch turnbuckles and a few bolts. Two turnbuckles are used between the thighs,—one directly in front of the other and parallel to it (Fig. 1). These two turnbuckles are manipulated at the same time during reduction. They are applied on the leg at the junction of the middle and upper thirds of the femora. Three six-inch turnbuckles are attached together with bolts and applied two inches above the internal malleoli.

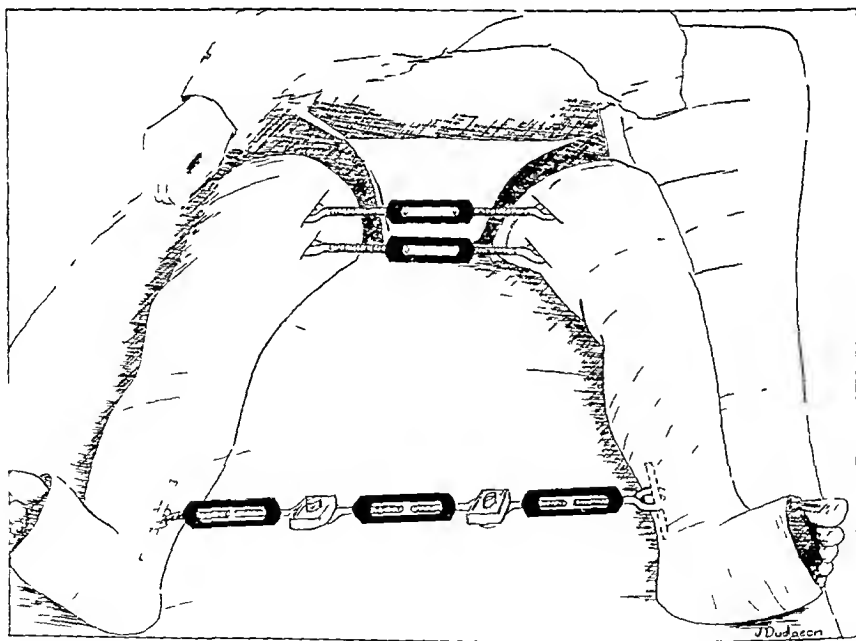


FIG. 1

The cast has been applied as it was in Case 1, and the reduction is to be started. The upper turnbuckles are to be slowly closed, and the lower ones slowly opened. Several turns of the turnbuckles will be made twice a day. Note at the ankles how the turnbuckles are held in the plaster; the aluminum strips are shown by dotted lines. The proximal turnbuckles are fixed to the plaster in a similar manner.

Whether the turnbuckles are applied open or closed depends upon the fracture.

A well-padded cast is applied from the toes to the groin bilaterally. After the plaster dries, the turnbuckles are incorporated, as shown in Figure 1, and are attached to the cast by several rolls of plaster. Strips of aluminum are run through the eyes of the turnbuckles to aid in attaching them to the plaster. The plaster is allowed to set for twenty-four hours before the manipulation of the turnbuckles is started.

Traction is applied in a horizontal plane by the turnbuckles. Both lower extremities are used as levers and pressure is applied through pull on the ligaments of the hip joints and on the ilia. This must be borne in mind as it is the basic principle of this type of traction.

CASE 1. A. R., a corporal, aged twenty-two, was injured on March 10, 1941, in a car wreck. The symphysis pubis was separated two and one-half inches, and the left sacro-iliac joint was dislocated. He was in extreme shock; later a large extraperitoneal abscess developed. Because of his serious condition, it was twenty-two days before an attempt could be made to reduce the fracture of the pelvis. At the time the cast and turnbuckles were applied, the pelvis was in the condition shown in Figure 2-A. A roentgenogram

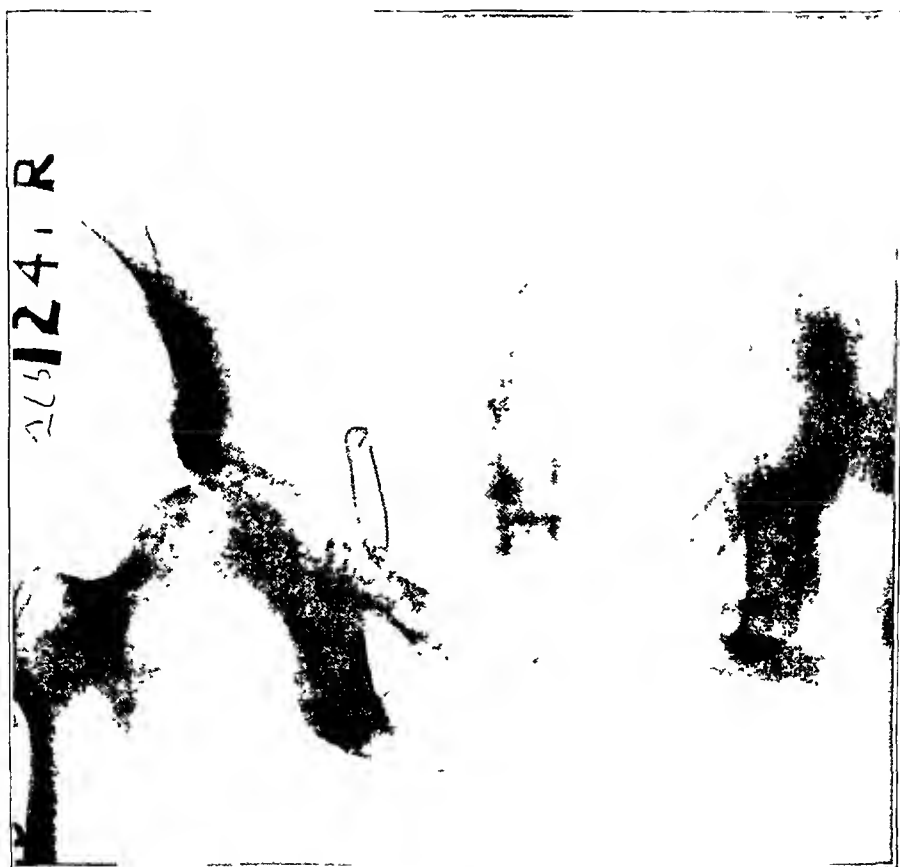


FIG. 2-A

Case 1. Roentgenogram taken at time of admission to Station Hospital, twenty-two days after injury, and before any reduction had been attempted.



FIG 2-B

Case 1. Roentgenogram, taken fourteen days after the turnbuckles were applied, and thirty-eight days after the injury, shows reduction of the pubis



FIG. 2-C

Case 1. Final result six months after injury. The left sacro-iliac joint remains unreduced, but is painless. The patient has returned to light duty at Camp Bowie, Texas

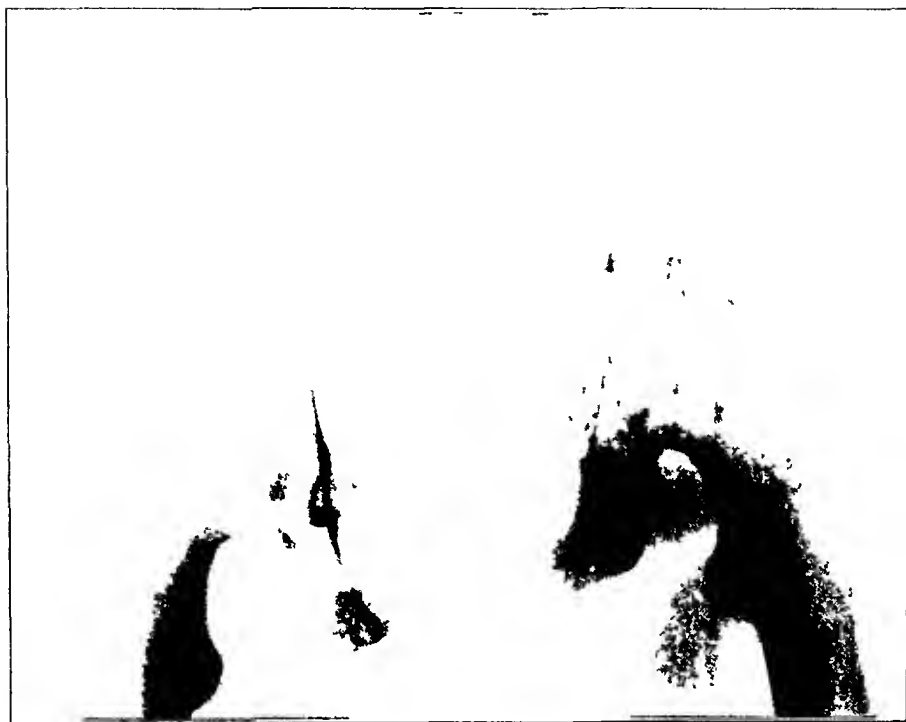


FIG. 3-A

Case 2. Roentgenogram, taken at the time of injury March 24, 1940, shows the head of the femur pushed through the acetabulum, with marked displacement.



FIG. 3-B

Case 2. Roentgenogram, taken March 28, 1940, shows the reduction of the fracture-dislocation by the use of turnbuckles.

taken two days later (Fig. 2-B), shows the reduction. Still later results are shown in Figure 2-C. The dislocation of the left sacro-iliac joint could not be reduced. When removed from the cast, the patient had complete foot-drop on the right, probably due to pressure from the cast on the common peroneal nerve at or behind the head of the fibula, but this had improved considerably by October 20, 1941, when he returned to light military duty, and had cleared up completely by November 25, 1941. He had no pain at this time.

In this case the upper turnbuckles were put in wide open and the lower ones completely closed. The upper ones were slowly closed, and the lower ones slowly opened over a period of ten days. The symphysis pubis was reduced first as it was considered the most important injury. The author was unable later to reduce the left sacro-iliac dislocation.

CASE 2. G. P., aged thirty-five, colored, while drunk, fell off a railroad bridge fifty feet to the river bank, and received a fracture-dislocation of the left acetabulum, with the head of the femur being rammed into the pelvis (Fig. 3-A). Plaster and turnbuckles were applied and the fracture was easily reduced in three days. The patient was kept in plaster for six weeks, and was allowed to bear weight at the end of eight weeks. He made a complete recovery in four months (Fig. 3-B). There have been no arthritic changes so far in this man.

In this case the upper turnbuckles were put in closed, and the lower ones open. The upper were slowly opened, and lower ones were slowly closed.

The author has seen two cases of pelvic fracture in women who had very considerable overlapping of the pelvic fragments. These were young women, desirous of having children. Turnbuckles were used, and excellent reductions were obtained.

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ABDUCTION OSTEOTOMETER

BY HENRY MILCH, M.D., NEW YORK, N. Y.

During the course of a series of studies undertaken to elucidate the factors influencing upper femoral osteotomy, a number of interesting data were disclosed and have been reported upon elsewhere^{2, 3, 4}. Generally speaking, osteotomy has been employed to produce (1) changes in the direction of the femoral axes, (2) changes in the position of the femur relative to the pelvis, and (3) changes in the comparative length of the two femora. Though an alteration in either one of these relationships may represent the primary indication for the operative intervention, it is manifestly impossible to accomplish the desired effect without at the same time inducing changes in each of the other relationships. A mature appreciation of the result of femoral osteotomy must, consequently, include a means of evaluating and simultaneously controlling each of these components.

Variation in actual length of the femoral shaft can usually be measured clinically with considerable accuracy. However, by far the greatest disparity in leg length arises, not from actual shortening, but from the apparent shortening which is caused by pelvic obliquity attendant upon ankylosis of the hip in abnormal positions. The problems to which this gives rise are complicated, and are far from solution. Some progress in the solution of the difficulty has been made by the observations of Lovett, Seddon, and others, on the relationship between the angle of abduction or adduction, and the difference between the true and apparent lengths of the limbs. The importance of these observations cannot be denied, but their validity can be admitted only provided it be stipulated that the difference in apparent length of the two limbs is due entirely to lateral inclination of the pelvis. This, of course, is not invariably true, since anteroposterior tilting of the pelvis, resulting from fixed flexion of the hip, may similarly lead to apparent shortening, which becomes greater as the angle of flexion increases (Fig. 1).

To establish the shortening which is due to adduction alone and, therefore, the angle of abduction necessary to correct the deformity, it is essential to deduct from the total the amount of shortening which is due to flexion alone. This is by no means a simple problem. In fact, it appears that by the methods at present employed, no completely accurate estimate of the degree of actual flexion of the hip can be obtained and, therefore, no adequate correction for the distortion can be made. To overcome this difficulty, it has been suggested that the present uncertain approximations be eliminated in favor of a more objective clinical measurement, based on the determination of the pelvifemoral angle⁵. By the use of this angle, it is possible to determine the apparent shortening which is due to flexion. Subtracting this amount from the total yields the

apparent shortening which is due to adduction and which can be corrected by abduction osteotomy. (This amount must be increased by a little over one-half inch to compensate for the 15 degrees of flexion, which is desirable, so as not to interfere with the patient's sitting position.)

The failure to make allowance for these factors in the tables prepared by Seddon, Lovett, and others, probably accounts, in part, for the excessive lengthening not infrequently observed after abduction osteotomy. But there are other reasons for questioning the validity of these tables. It is to be noted that they are based on two primary assumptions: (1) that the osteotomy is to be performed at the extreme upper end of the ankylosed femur, and (2) that the femur is a straight bone of the

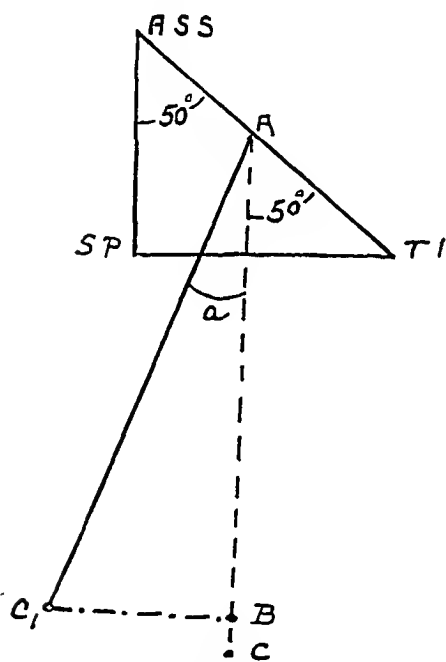


FIG. 1

ASS=Anterior superior spine. SP=Symphysis pubis. TI=Tuberosity of the ischium.

The line joining ASS to SP is in the frontal plane. The line joining ASS to TI is Nelaton's line. It lies in the axial plane of the pelvis and makes an angle of 50 degrees with the frontal plane. The femur, AC, in the extended position, is parallel to the frontal plane and makes a pelvifemoral angle of 50 degrees with Nelaton's line. The angle a is the angle of flexion deformity. $AC - AC_1 = L$ (the length of the femur). The shortening (S) due to flexion = $BC = (AC - AB)$. Since $AB = L \cos a$, $S = L - L \cos a$.

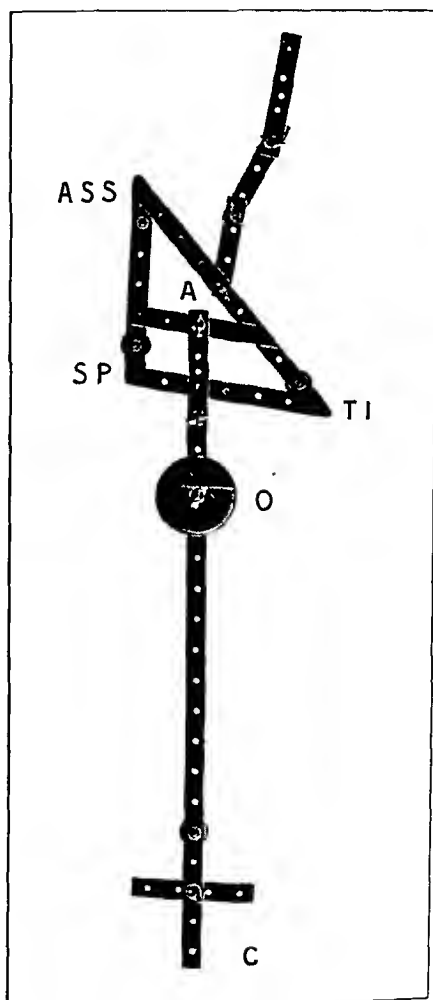


FIG. 2

Model of lateral outline of the pelvis and femur. The vertical bar ASS to SP represents the frontal plane in which the anterior superior spines and the symphysis pubis lie. The horizontal bar SP to TI represents the plane in which the symphysis and the ischial tuberosity lie. A represents the hip joint. The femur is approximately parallel to the frontal plane and makes an angle of about 50 degrees with the axial plane of the pelvis.

broom-stick type. These are obviously not consistent with the clinical facts.

Abduction osteotomy is but seldom, if ever, performed at the upper end of the femur,—that is, through the hip joint. Though this may be, theoretically, the ideal site for osteotomy, practical experience has established the preference for other levels, especially in the subtrochanteric region. Since the angle of abduction indicated by the tables is estimated on the assumption that the osteotomy is to be performed at the hip joint, the choice of any other osteotomy site necessarily involves a corresponding change in the angle of abduction, if the same effect is to be accomplished. It has been shown⁴ that the lower the level of osteotomy, the greater must be the angle of abduction. Moreover, it can be shown that the lower the level of osteotomy, up to the mid-point of the bone, the greater is the degree of femoral shortening which is due to the osteotomy itself. It is, therefore, apparent that, before determining the desired angle of abduction, the tables must be further modified, so as to take into account the level at which the osteotomy is to be performed.

Still other factors must be taken into consideration. These are the angle of the femoral neck and the length of the femoral neck. The effect of abducting a femoral neck already in valgus will be entirely different from that accomplished on a neck in marked varus. Abduction of the distal, femoral

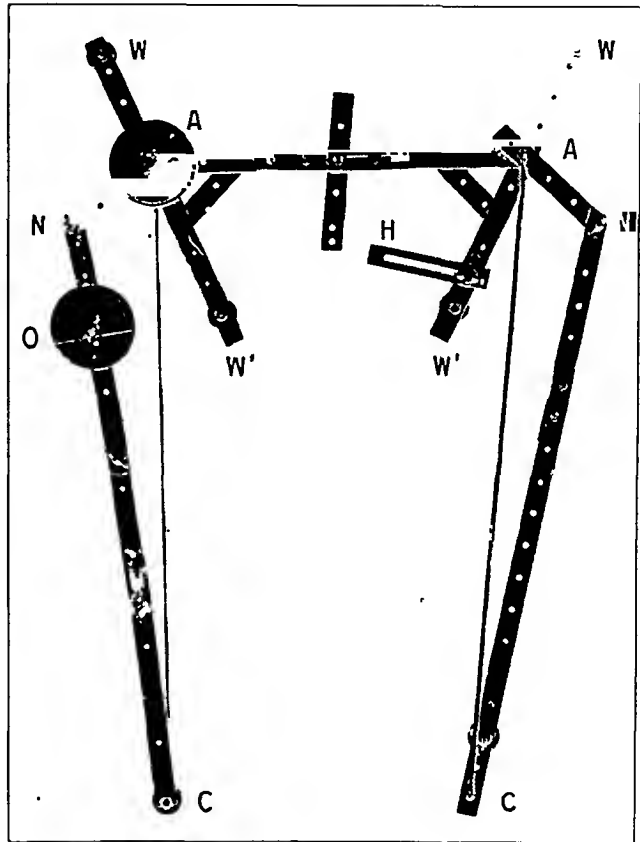


FIG. 3

Model of the anteroposterior outline of the pelvis and femora, for use in unilateral cases. The inclination of the outer pelvic wall (WW') is fixed at 210 degrees to the mid-line. AN represents the neck of the femur, NC the shaft of the femur, and O indicates the site of osteotomy. The slotted bar H is a brake to limit adduction of the left femur. AA represents the interfemoral distance.

The spring AC uniting the right femoral head to the mid-condylar area represents the mechanical axis. The effect on the mechanical axis of abduction at the hip joint, of abduction at the base of the femoral neck, or below the trochanter, can be measured by means of the inserted arcs.

fragment is clearly identical with abduction of the proximal fragment in relation to the distal portion of the osteotomized femur, and abduction of the proximal fragment is equivalent, within certain limits, to increasing the valgus of the femoral neck and thereby of increasing the actual length of the femur. But simultaneous with this increase in length, due to increasing valgus of the neck, there occurs an associated shortening of the femur, due to angulation of the shaft. The resultant change in length will, therefore, depend upon the reciprocal relationship between these two effects.

Yet even this does not exhaust the difficulties inherent in what has been considered the simple osteotomy procedure. The femoral neck introduces still another disturbing element in the already hectic problem,—the mechanical axis of the femur. Though stress is actually distributed

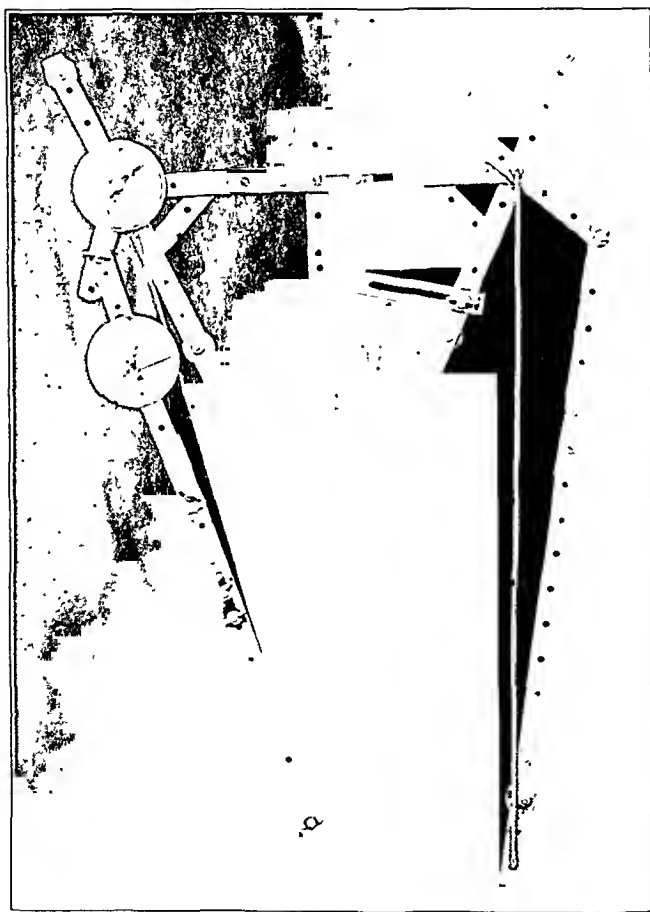


FIG. 4

The right hip is ankylosed. The right femoral shaft is one and five-eighths inches shorter than the left. The femoral neck on the right side is one inch shorter than the left. Yet, by actual measurement, the right femur is only one and one-half inches shorter than the left, because of the increased length which resulted from increasing the angle of the right femoral neck from 125 degrees to 150 degrees.

through the neck to the anatomical axis or shaft of the femur, function must be considered as occurring along an imaginary line—the mechanical axis—which extends from the femoral head to the mid-condylar region. When the term “parallelism of the legs” is used, it is “parallelism of the mechanical axes” and not of the anatomical axes that is intended. The measure of useful abduction is, therefore, not the amount by which the shaft of the femur has been angulated, but, on the contrary, the degree to which the mechanical axis has been shifted.

While the physiological effect of osteotomy is acquired from a change in the position of the mechanical axis, it is surgically accomplished by an-

gulation of the anatomical axis. At first sight, this would not seem to present any serious obstacle. Since the abduction of the mechanical axis is dependent upon that of the anatomical axis, it would appear reasonable to surmise that the measure of abduction of the one might be taken to be the measure of abduction of the other. However, it soon becomes apparent that the clinical estimation of abduction of the anatomical axis is an extremely inaccurate guide to the degree of abduction of the mechanical axis. In the course of the previously mentioned studies, it was found that the level at which the osteotomy was performed profoundly modified the results obtained. It was observed that, under certain circumstances, the position of the mechanical axis could be made to vary without changing the angle of abduction of the distal portion of the osteotomized femur. Under other circumstances the position of the mechanical axis could be fixed, even though the abduction of the osteotomized femur were increased or decreased.

From the survey of all of these considerations, and from the realization of the intimate relationship of all these different factors, it was appreciated that osteotomy of the femur so altered the relative positions of the anatomical and mechanical axes that no simple and invariable statement of these relationships could be devised. Indeed, the mathematical statement of the interrelationships would involve the calculus of several variables and result in a formula so complicated as to be of no practical, clinical value.

In the solution of this difficulty a pelvic model, made from steel parts resembling an erector set, proved of incalculable value

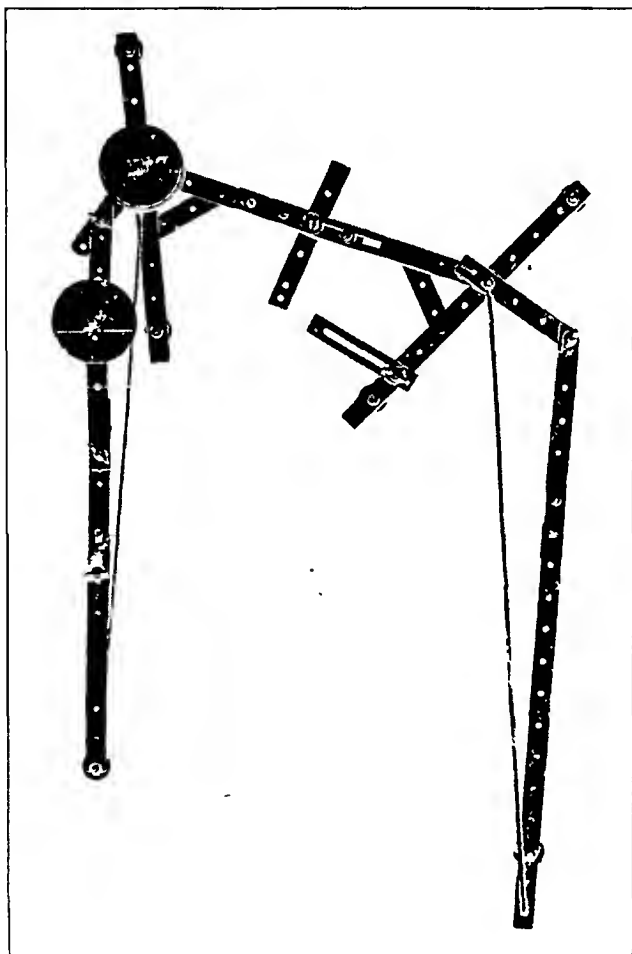


FIG. 5

The legs have been made parallel by tilting the left pelvis downward about 13 degrees. This has resulted in an apparent shortening of about four inches.

(Figs. 2 and 3). Though it was originally intended merely as a manikin for teaching purposes, it was found that when adjusted to anatomical dimensions it could be made to serve as an instrument of considerable precision. By its use, the angle of abduction of the anatomical axis necessary to achieve the desired change in the position of the mechanical axis, while at the same time preserving parallelism and equality of limb length, may be easily determined preoperatively.

The apparatus has been made so that the roentgenographic measurements of actual cases may be reproduced. The present model has been devised for the study of unilateral conditions, and the left side is represented as normal. By duplicating the construction of the right side, the model may be adapted to the study of bilateral conditions. The width of the pelvis may be modified, but the inclination of the outer wall of the pelvis has been fixed at approximately 210 degrees. By the conversion of the fixed union into a movable joint, the angle of inclination

of the pelvic wall may be adjusted to any desired angle. The upper end of the femur is joined to the pelvis by a set screw passing through at the level of the acetabulum. The hip joint may be permitted to remain mobile, or may be locked to simulate ankylosis at any angle of lateral deviation. Another joint has been made at the top of the femoral shaft, so that the angle of the femoral neck may be changed or fixed at will. By means of the series of drill holes or slots, the length of the femoral neck and of the femoral shaft may be altered. At a point about four inches below the base of the femoral neck, a joint inserted into the femoral shaft simulates

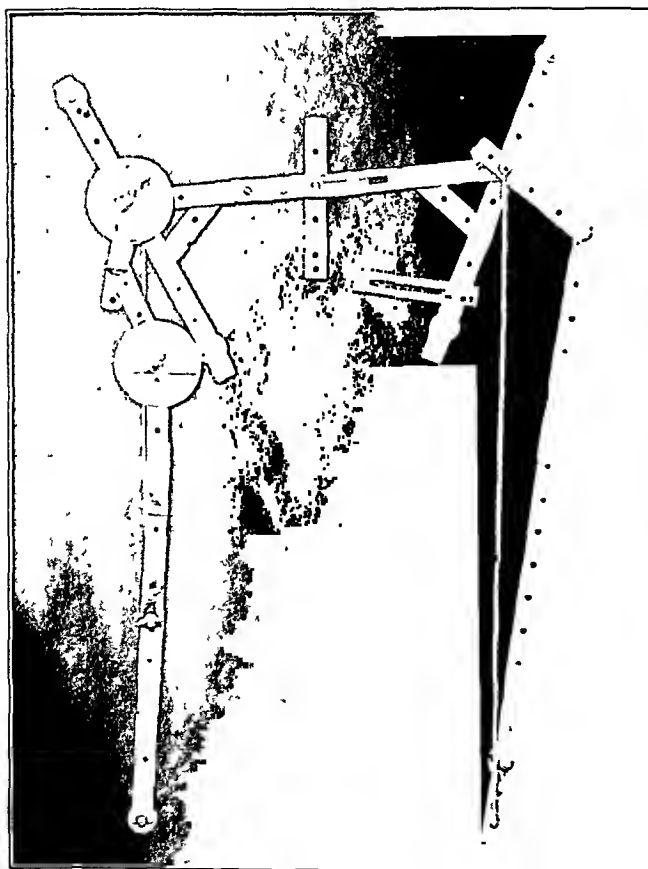


FIG. 6

Osteotomy performed four inches below the base of the femoral neck. In order to restore "parallelism of the limbs", and correct the apparent difference in length, the distal fragment must be abducted 30 degrees from its former axis. This results in a fixed *upward* tilt of the left pelvis of about 8 degrees.

an osteotomy level, and permits measurement of the degree of abduction or adduction of the distal fragment.

The method of application and the clinical value of the device, may, perhaps, best be exemplified by the following hypothetical illustration. Let it be assumed that the conditions found in a given patient are as seen in Figure 4. As the result of a suppurative process, the right leg has become ankylosed in a position of adduction. The flexion component may be disregarded, since it does not exceed 15 degrees. The right femoral shaft, from the tip of its trochanter to the condyles, measures sixteen and seven-eighths inches, as compared with the left, which measures eighteen and one-half inches. There is actual shortening of the right head and neck to two inches, as compared with three inches on the left side. The angle of the right femoral neck is 150 degrees, as compared with the left, which has remained at 125 degrees. By actual measurement, the right femur, from the hip to the knee, measures eighteen and one-half inches, while the left measures twenty inches.

The real difference in length is one and one-half inches. When both mechanical axes are brought into parallelism (Fig. 5), the left side of the pelvis is tilted downward and the left leg is apparently lengthened, so that the apparent difference between the two legs is increased to four inches, an increase of two and one-half inches over the real shortening. According to the tables for lateral deviation, prepared by Lovett, the difference of two and one-half inches between the real and apparent lengths of the femora in a pelvis eleven inches wide, indicates an adduction of 13 degrees in the affected femur. According to Seddon's table, the adduction of the affected femur must be considered as being not greater than between 8 and 10 degrees.

According to the tables of either Lovett or Seddon, abduction of 10 to 15 degrees should lead to adequate correction of the deformity, with regard both to restoration of parallelism of the limbs and to parity in their apparent lengths. Reference to the model, however, reveals that this is not the fact. Indeed, the divergence between the observed and calculated results is so great that it renders the tables not only useless, but, in fact, misleading.

In Figure 6 it can be seen that when the osteotomy is performed at a distance of four inches below the base of the neck, the distal fragment of the femur must be abducted to an angle of 30 degrees from the axis of the proximal fragment, in order to restore the parallelism of the limbs and at the same time to overcome the apparent difference in limb length. This results in a fixed *upward* tilting of the pelvis of about 8 degrees on the side opposite the affected limb. The total shift of the left pelvis from minus 15 degrees to plus 8 degrees, is sufficient to compensate for the actual shortening of one and one-half inches, and the apparent shortening due to the adduction deformity. By implication, it would seem that abduction of the femur 23 degrees would accomplish this result, as indeed it would, provided the osteotomy were performed at the level of the hip joint.

Though this degree of abduction is greater than would have been believed from the use of the standard tables, it is still less than the 30 degrees indicated by the osteotometer. This is, of course, due to the fact that the osteotomy has been performed at a level four inches below the acetabulum.

SUMMARY

Because of the presence of the femoral neck and the conversion of the femur into a hockey-stick shape, simple osteotomy of the upper end of the femur entails a number of complicated changes, which cannot be calculated by any simple table of relationships. To facilitate the calculations which are necessary in the performance of an upper femoral osteotomy, a mechanical model has been constructed.

The device here suggested provides a relatively easy method for determining, preoperatively, the exact site and angle of deviation for any abduction osteotomy of the femur. It permits the experimental study on a pelvic model of the effect of osteotomy in any given femur. It eliminates the necessity of cumbersome tables and immediately establishes the resultant of a number of variable factors to be considered in osteotomy. By appropriately adjusting the model to the measurements, as determined by roentgenograms, the postoperative result can be checked and adequate correction made before union has occurred at the site of osteotomy. The apparatus is simple to operate and both simple and inexpensive to construct.

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ANGIOMA OF THE FOOT *

BY SAMUEL KLEINBERG, M.D., F.A.C.S., NEW YORK, N. Y.

Primary angioma of bone is *clinically* uncommon in any part of the skeleton, but especially so in the bones of the extremities. Clinical manifestations appear only if the tumor has destroyed enough of the bone to cause its collapse, or has expanded the bone so that there is pressure on the adjacent soft tissues, causing pain or some functional disturbance. Asymptomatic angiomas of bones, notably the vertebrae, are found frequently at autopsy. Töpfer found an incidence of 11.93 per cent. in 2,154 spines. Presumably there are many angiomas in other bones without clinical evidences.

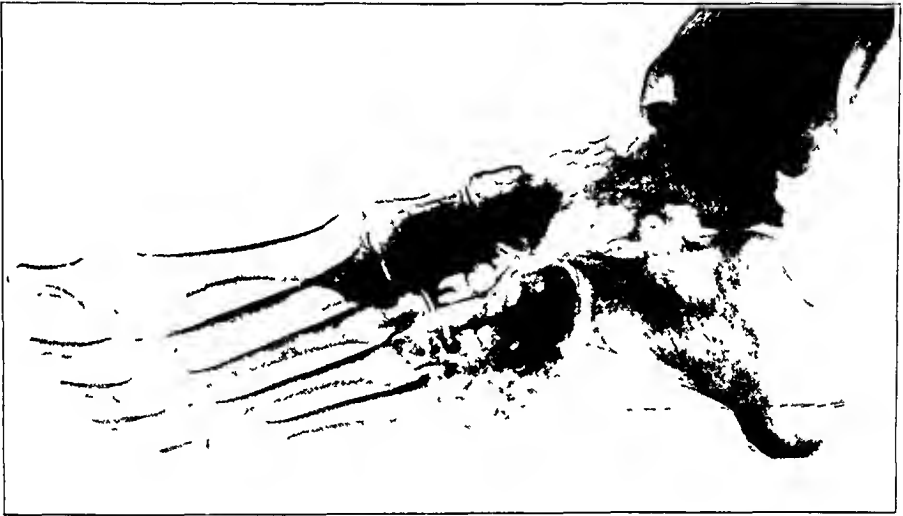


FIG. 1-A

January 20, 1940. Lateral view of the right foot.

Note the partial disappearance of the cuboid and external cuneiform bones, and the numerous cysts of varying size and shape surrounded by thin walls. There are many phleboliths.

An angioma in bone produces marked and rather characteristic, but not pathognomonic, roentgenographic changes. In the vertebrae there are vertical columns of dense bone separating rarefied areas. In the flat bones the dense trabeculae of bone are so arranged as to give a sunburst appearance. In the long bones the lesion is commonly seen as a multiloculated change which replaces the bone, but which does not perforate the periosteum or the epiphyseal plate. The frequency with which angiomatous lesions affect bone in contrast to other tissues can be judged by the figures quoted by Geschickter and Keasbey. They

* The text is based on a presentation made before the Orthopaedic Section of the New York Academy of Medicine, November 21, 1941.

found that among 570 angiomata collected at the Johns Hopkins Hospital, there were twelve instances of primary involvement of bone, about 2 per cent. In the Radiographic Department of the Hospital for Joint Diseases, where thousands of patients are x-rayed every year, only three or four angiomata of bones in the extremities have been seen in the last ten years.

Lillian Z., nineteen years old, consulted the author on January 3, 1940, for pain in the sole of the right foot, and a limp. The limp had been present intermittently for eleven years; recently it had become pronounced. The pain, formerly occurring only occasionally and only as a mild discomfort, increased in severity, so that the girl was decidedly disabled. Her mother stated that even during her early childhood the patient tired easily and was disinclined to walk, so that it may be fairly assumed that the lesion in the foot had its inception during childhood.

The examination revealed an individual in seemingly good general condition, who walked with a decided limp on the right side. There was a mild atrophy in the right thigh and leg. A mass, about the size of an egg and exceedingly tender to pressure, was seen and felt on the plantar surface of the right foot. It was soft, elastic, deep-seated, diffuse, and non-pulsating. There was no tumefaction on the dorsum of the



FIG. 1-B

January 20, 1940. Dorsoplantar view of both feet. (Roentgenogram reversed.)

There is a multiple cystic disease of the cuboid and external cuneiform bones, and marked atrophy of the metatarsals, in the right foot.

foot, but pressure over the cuboid and cuneiform bones caused moderate pain. The hip, knee, ankle, and toe joints were freely movable.

The roentgenograms (Figs. 1-A and 1-B) of the foot showed an extensive destructive lesion in the cuboid and external cuneiform bones. In the cuboid the inner two thirds were involved, and in the cuneiform the entire bone appeared to be affected. The osseous tissue was replaced by cystic areas which varied in size and shape, and which were surrounded by narrow walls of bone of lesser or greater density. In some areas the trabeculae of bone were very sclerotic. The other bones of the foot appeared to be underdeveloped, especially the metatarsals. The exact diagnosis was not certain, but from the history, the chronic course of the illness, and the absence of any evidence of invasiveness, it seemed very likely that the condition was a benign tumor. Accordingly, an operation for excision of the neoplasm was advised and performed.



FIG. 2

Photomicrograph ($\times 20$) of a portion of the external cuneiform bone. Note the numerous blood spaces lined by endothelium and separated by thin connective-tissue walls

Operation. On February 29, 1940, the mass in the sole of the foot was palpated and its location definitely noted before a tourniquet was applied. It was well that this had been done because, following the application of the Esmarch bandage, the mass could no longer be felt. This observation promptly suggested a vascular lesion. A three-inch incision was made on the medial side of the plantar surface of the foot, exposing between the first and second layers of muscles a mass of varicose veins,—that is, an angioma. Further dissection revealed that the mass was made up of blood vessels which had entered it from all directions. Anteriorly some of these vessels had entered the tarsal bones. As many main vessels as possible were ligated, leaving a removable mass as big as a prune. The tourniquet was released, and no bleeding was found in the wound, which was thereupon closed in layers without drainage. A two-inch incision was then made on the dorsum of the foot, and was deepened to bone. From the external appearance of the bone, except for a slight lateral displacement of the cuboid on the os calcis, there was no evidence of a tumor. However, upon cutting through and reflecting the thin cortex on the outer surface of the cuboid, the cancellous bone was found to be replaced by a vascular neoplastic tissue which was readily removed with a curette.



FIG. 3-A

FIG. 3-B

Roentgenograms made twenty months after operation. The cystic areas in the cuboid are replaced by bone of a substantial structure. The removed cuneiform bone is represented by only a small shadow of bone.

The external cuneiform was almost completely replaced by tumor tissue and was excised practically *in toto*. There was very little bleeding. Both wounds healed by primary union.

The pathological examination showed that the mass removed from the sole of the foot was angiomatous and contained many phleboliths. The cuneiform was greatly rarefied, only a shell remaining, and was filled with angiomatous tissue. The microscopic examination (Fig. 2) showed a capillary hemangioma with considerable blood pigment in the supporting tissue and phleboliths in all stages of organization and calcification.

Since all of the angiomatous tissue could not be and was not removed, the patient was given deep x-ray therapy of 750 roentgen units directed to the plantar and to the dorsal aspects of the foot, making a total of 1500 roentgen units, which was considered adequate by the roentgenologist.

The foot remained swollen and sensitive for many months. Weight-bearing was avoided for the greater part of a year, by the end of which time all symptoms had disappeared. At present there is no sensitiveness on pressure and she can walk without pain. Roentgenograms (Figs. 3-A and 3-B) taken in October 1941 showed that the operative defect in the cuboid has been almost completely replaced by bone of normal texture. In the gap between the cuboid and the middle cuneiform, some normal bone has been deposited.

There is here reported a case of a benign capillary hemangioma of a foot, involving the cuboid and the external cuneiform bones and the soft tissue in the sole of the foot. There was undoubted vascular communication between the lesion in the bones and that in the plantar area. It is not possible to state in which of these areas the angioma began. Perhaps, as in other cases with multiple lesions, the angioma appeared in the various areas simultaneously. The angiomatous growth evidently started many years previously, in childhood, and, while it had periodically caused some symptoms, these were not severe until shortly before the patient was seen by the author when, because of marked pain and disability, she was compelled to seek relief. The roentgenograms presented a characteristic multicystic appearance, yet the diagnosis was not made until the time of operation, when the disappearance of the mass after a tourniquet was applied to the thigh suggested the probable pathology. Healing progressed very slowly and swelling of the foot persisted for a long time, but at the present time the patient has no symptoms and is apparently cured.

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OSTEOCHONDRITIS JUVENILIS OF THE ACETABULUM *

BY PAUL R. LIPSCOMB, M.D., ROCHESTER, MINNESOTA

Fellow in Orthopaedic Surgery, Mayo Foundation

AND CARL C. CHATTERTON, M.D., ST. PAUL, MINNESOTA

Chief of Staff, Gillette State Hospital for Crippled Children

Although more than 700 articles have been written on osteochondritis of the centers of ossification, few authors have mentioned the acetabulum. As far as can be ascertained, only one writer, Froelich, described a case of osteochondritis in which the acetabulum was involved without obvious involvement of the neighboring head of the femur. In this case, both acetabula were involved and the changes described were similar to those presented in the authors' cases.

The authors believe that the acetabulum is involved much more often than generally is recognized, either with the head of the femur or alone. In order to substantiate this view three cases are reported in which the acetabular structure was involved without obvious involvement of the neighboring head of the femur, and two cases in which the acetabulum was involved in conjunction with the femoral heads and other centers of ossification.

REPORT OF CASES

CASE 1. A boy, fourteen years of age, was admitted to the Gillette State Hospital for Crippled Children on September 5, 1935, complaining of pain in the right hip with an accompanying slight limp of one year's duration. Examination of the hips revealed only slight limitation of motion. Anteroposterior roentgenograms revealed irregular areas of decreased and increased density, fuzziness, mottling, marginal proliferation of bone, and fragmentation which involved the iliac or superior half of both acetabula (Fig. 1-A). The patient was confined to bed and the pain promptly disappeared. He was dismissed from the Hospital on December 13, 1935. It was necessary to hospitalize him again for twenty-two days in August and September, 1936, because of recurrent symptoms. However, with rest in bed these promptly disappeared.

Motions of both hips were entirely normal when the patient was last examined on May 11, 1939, and roentgenograms on that date revealed entirely normal acetabula (Fig. 1-B).

CASE 2. A girl, ten years of age, was admitted to the Hospital on March 22, 1941, complaining of pain in the right hip accompanied by a limp of six weeks' duration.

Examination revealed an apparent increase of one inch (2.5 centimeters) in the length of the right lower extremity. Abduction and external rotation of the right hip were moderately restricted. Roentgenograms on admission revealed that the superior border of the right acetabulum was fragmented and fuzzy, although the epiphysis of the femoral head appeared normal (Fig. 2-A).

Treatment consisted of Buck's adhesive extension with traction of eight pounds (3.6 kilograms) to the right leg and application of a Thomas splint to maintain the extremity in abduction. The pain disappeared immediately. Fifty-three days after admission, the patient was dismissed as clinically and subjectively cured. However,

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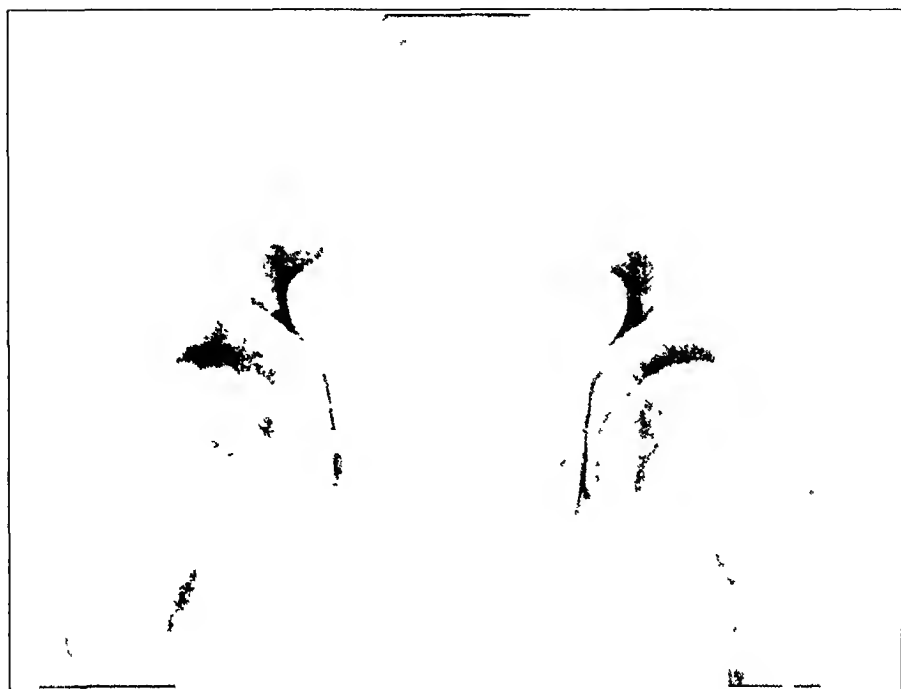


FIG. 1-A

Case 1. September 6, 1935. Areas of decreased and increased density, with marginal proliferation of bone and fragmentation involving the iliac portions of the acetabula, may be seen, although the heads of the femora are entirely normal.



FIG. 1-B

May 11, 1939. The acetabula are smooth, of normal density, and of entirely normal appearance.



FIG. 2-A

Case 2. March 24, 1941. There is extensive fragmentation of right acetabulum, with a question of formation of loose bodies at the junction of the iliac and pubic portions; the head of the femur does not appear involved, although osteoporosis is already apparent.

roentgenograms taken on April 21, 1941, revealed no improvement; if anything, the fragmentation was more marked (Fig. 2-B). On further study of the roentgenograms, it was thought that beginning involvement of the femoral epiphysis could be detected, but this was not certain.

CASE 3. A girl, one year of age, was admitted to the Hospital on April 28, 1932. Roentgenograms revealed congenital dislocation of the right hip. Treatment consisted of traction on a Coonse abduction frame. The patient was dismissed on December 15, 1932, with a complete range of motion in the hip, and the condition was apparently cured. She was examined at regular intervals. At the last examination on February 20, 1941, at which time the patient was ten years of age, she walked without a limp. Reaction to the Trendelenburg test was negative. Roentgenograms revealed that both femora were in adequate acetabular cavities, although the acetabula, especially the right acetabulum, gave evidence of circulatory disturbances (Fig. 3).

In the next two cases, although changes were present which predominantly involved the acetabula, the roentgenograms also revealed changes in other centers of ossification.

CASE 4. A boy, nine years of age, entered the Hospital on October 22, 1931, complaining of pain in the left inguinal region, which extended down the left thigh to the knee. Onset of symptoms dated back about a month prior to admission, at which time he had fallen from a porch and had struck the lateral side of the left thigh.

Examination revealed moderate limitation of flexion and internal and external rotation. Roentgenograms revealed a suggestive area of decreased density, about two or three millimeters in diameter, in the epiphysis of the left femoral head, and definite

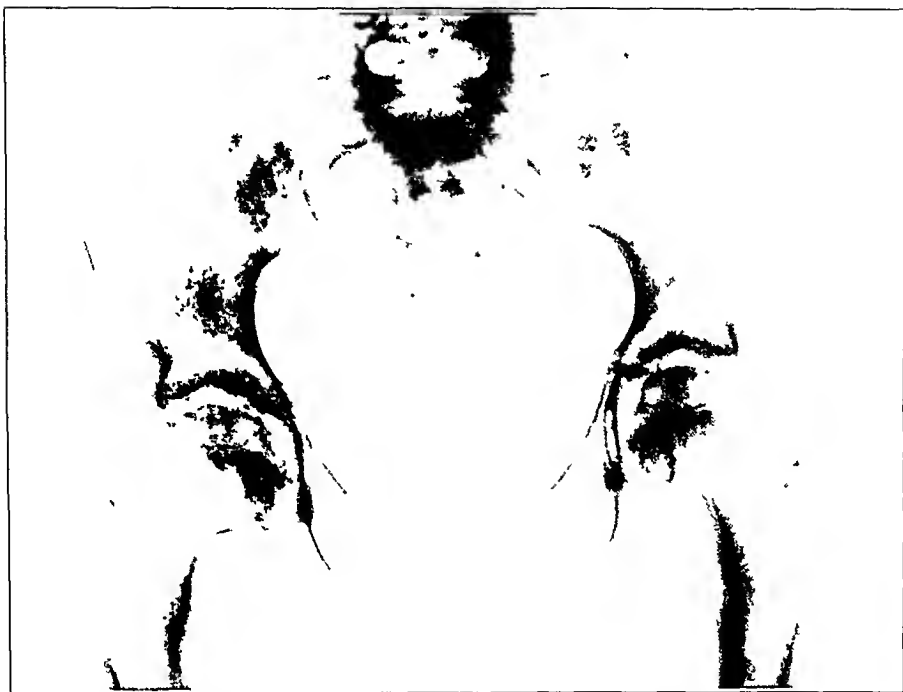


Fig. 2-B

Case 2. April 21, 1941. Changes are even more marked than in Fig. 2-A. Osteoporosis of the head is more pronounced, and there may be slight involvement evidenced by the small, punched-out area where the postacetabular margin bisects the femoral epiphysis.



FIG. 3

Case 3. February 20, 1941. Both acetabular cavities are involved, especially the right. On careful examination three or four small, loose bodies can be distinguished in the joint.

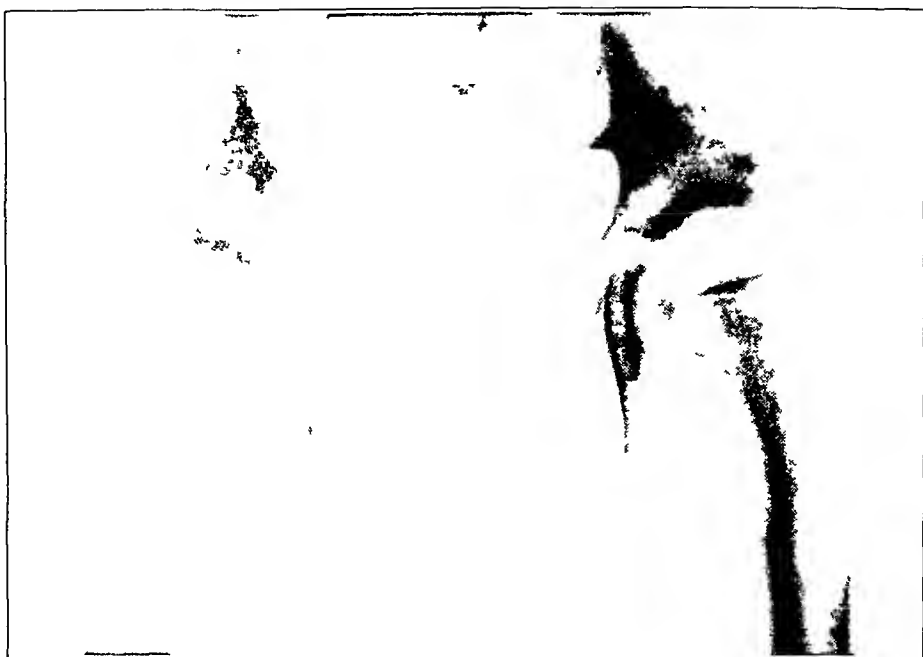


FIG. 4-A

Case 4 October 22, 1931. Changes, especially marked on the left, extend into that portion of the triradiate strip formed by the junction of the iliac and pubic bones, the epiphysis of the left femoral head is also involved.



FIG. 4-B

March 29, 1934. Acetabular changes are not so marked, and the triradiate strip is no longer involved on the left, where fusion is almost complete. Fusion has not progressed to the same extent on the right and there is still some involvement of the triradiate strip. The punched-out area in the left femoral epiphysis has completely disappeared.



FIG. 5-A

Case 5. May 9, 1939. The acetabula are extensively involved, as are also the heads and necks of the femora. Several loose bodies can be distinguished in the joint spaces.



FIG. 5-B

March 9, 1940. Involvement of the acetabula is more marked than in Fig. 5-A.

mottling, with areas of increased and decreased density, which involved the superior portions of both acetabula (Fig. 4-A).

Treatment consisted of traction followed by a plaster-of-Paris cast of the short hip-spica type. This was removed after one and a half months, and the patient was dismissed on February 11, 1932; marked improvement had occurred. Roentgenograms at this

time disclosed marked improvement, and the change in the femoral epiphysis was hardly detectable.

The last roentgenograms of the hips were taken March 29, 1934 (Fig. 4-B); although changes in the acetabula were still present to a slight extent, they were not as marked as previously.

CASE 5. A boy, eight years of age, was admitted to the Hospital on May 9, 1939. There was roentgenographic evidence of definite osteochondritis involving the lumbar vertebrae, the heads of both femora, and the acetabula, with enlargement of the acetabular cavities and rarefaction and condensation of bone (Figs. 5-A and 5-C). In this case the roentgenographic appearances of the acetabula are of interest. The most recent roentgenograms, taken on March 9, 1940, disclosed progression rather than regression of the condition (Fig. 5-B).

COMMENT

The three primary centers of ossification which form the ilium, ischium, and pubis are present at birth; however, at this time the greater part of the acetabulum is cartilage. By the tenth

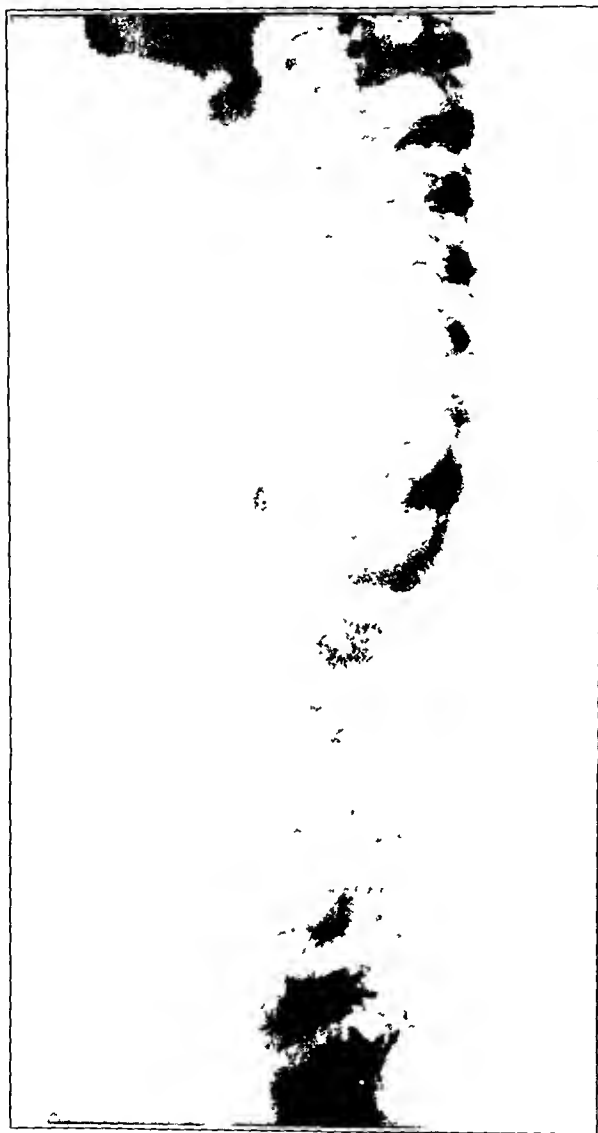


FIG. 5-C

Case 5. January 17, 1940. Osteochondritis of practically all lumbar and thoracic vertebrae.

year of life the cartilage in the three bones at the acetabulum is reduced to a triradiate strip. Two or three secondary centers appear in this strip, one of which forms the os acetabulum at the age of twelve years³. From the ages of the patients affected and their roentgenographic appearances, the disturbance seems to have been in the primary centers, with the possible exception of Cases 2 and 3. Furthermore, inasmuch as the superior

or weight-bearing surface of the acetabulum was chiefly involved, it would appear that the iliac center of ossification at the acetabulum is most likely to be affected, although it is not illogical to assume that the other centers also may be involved.

Several authors, Jansen in particular, described the variations of contour of the acetabulum which accompany osteochondritis of the femoral epiphysis. At an early date the acetabulum is widened, either actually or relatively and the depth of the cavity is diminished. Jansen was of the opinion that these changes preceded those in the femoral head, but most writers have considered them secondary. Waldenström stated⁹: "There is no change in the shape of the acetabulum at first, this change taking place secondarily, as an adaptation of the socket to the deformed caput, and only after some time." He further stated that only when the head assumed its final shape was this adaptation of the socket complete. Gill agreed with Waldenström, but in addition stressed that the acetabulum does not become altered if it is protected from the forces of weight-bearing and muscle pull exerted on and through the softened head. Platt stated that in the later stages: "The final shape of the hip-joint socket is in conformity with the final shape of the head", and this has been demonstrated by most observers time and again.

The writers agree with these authors that this is the natural variation of contour in the acetabulum in those cases in which the structural variation is confined to the head and neck of the femur. It is, however, with the structural variations of the acetabulum that we are chiefly concerned. These have been described by Platt in conjunction with the Legg-Calvé-Perthes type of osteochondritis. Regions of condensation and rarefaction, with an appearance similar to that of the femoral neck adjacent to the epiphyseal cartilage, are present in the subchondral portion of the bone. For the details the authors recommend King's excellent summary of the changes which occur in osteochondritis juvenilis in the acetabulum, as well as in the other centers of ossification.

They disagree with other authors concerning these structural changes, for they believe that, in a certain percentage of cases, structural changes similar to those in the femur take place in the acetabulum coincidentally with, and not secondarily to, the changes in the femoral head and neck. They further believe that in certain, perhaps isolated, cases there is a structural change in the acetabulum, without any detectable change in the head and neck of the femur.

The cases reported substantiate this view, for it would seem that the primary changes were in the acetabulum. However, in those cases in which alterations in the femoral head were present, acetabular changes were coincidental with, and not secondary to, those in the former. It seems, therefore, that when structural changes occur in the acetabulum, these changes are either primary or in conjunction with the changes in the femoral head, whereas the variations in the contour of the acetabulum are mainly secondary to the changes in the femur.

In the cases reported, clinical symptoms were unilateral, yet in practically all instances both acetabula presented roentgenographic evidence of changes of varying degree. The authors are not prepared to say whether this represented potential involvement of the other hip. Along this same line of thought, Outland and Flood reported two cases of osteochondritis dissecans of the acetabulum, in which the roentgenograms revealed that all four hips contained loose bodies, in spite of the fact that the symptoms were referable to only one hip in each case.

In Case 3, the changes followed an excellent result of treatment of a congenitally dislocated hip during the second year of life by means which were practically atraumatic. In reviewing a series of cases of congenital dislocation of the hip, several cases were found in which changes in the femoral epiphysis and acetabulum were present. However, Case 3 is the only case found in which changes in the acetabula only were present. Time alone will tell whether clinical symptoms will eventually present themselves in this case.

Little or nothing can be added to the entangled and theoretical discussion relative to the etiology of osteochondritis juvenilis, but the authors are of the opinion that this condition, at least in these cases, is probably due to a circulatory disturbance which is possibly aggravated by trauma. This is evidenced by the fact that the structural changes seem to involve the superior or weight-bearing surface of the acetabulum, while the inferior surface is little affected.

Treatment should be along the same lines as that used for the type of osteochondritis affecting the femoral epiphysis,—namely, rest of the involved part. Whether this is secured by rest in bed, traction, crutches, Thomas walking calipers, or by casts seems to matter little. Judging from the two cases in which healing took place, there seems to be little, if any, residual deformity; therefore, rest probably does not need to be as strictly enforced as in the Legg-Calvé-Perthes type of osteochondritis.

SUMMARY AND CONCLUSIONS

The literature presents comparatively little concerning osteochondritis juvenilis affecting the acetabulum. Only one case has been reported previously in which the acetabulum was involved without changes in the corresponding epiphysis of the femoral head. In three of the cases, the acetabula were involved without changes detectable roentgenographically in the femoral epiphyses. In addition, two cases were reported in which other centers of ossification also were involved.

Osteochondritis juvenilis of the acetabulum may affect the primary centers of ossification or it may involve the secondary centers. The change is most likely to occur at the superior rim or surface of the acetabulum. Treatment is conservative and should be directed toward relief of the strain which results from weight-bearing on the involved region. An analysis of the two cases in which healing took place reveals the fact that there seems to be little, if any, remaining deformity.

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PROGNOSIS IN BONE AND JOINT TUBERCULOSIS

AN ANALYSIS OF THE RESULTS OF TREATMENT AND A CONSIDERATION OF THE FACTORS WHICH INFLUENCE THE END RESULT *

BY R. I. HARRIS, M.D., AND H. S. COULTHARD, M.D., TORONTO, ONTARIO

*From the Toronto Hospital for the Treatment of Tuberculosis
(Weston Sanatorium), Weston, Ontario*

What result may be expected from treatment of tuberculous bones and joints? This can only be determined by the careful examination of the results over a long period of time. Tuberculosis of bones and joints is a disease easy to alleviate, but hard to cure. The achievement of cure, moreover, is profoundly influenced by a variety of ancillary factors, apart from the manner of treatment. The analysis which follows is an attempt to determine the present status of all the cases of bone and joint tuberculosis which have been treated in the Toronto Hospital for the Treatment of Tuberculosis, Weston, and to determine the factors which influence the prognosis.

MATERIAL AVAILABLE FOR STUDY

In the ten years between January 1931 and December 1940, there were discharged from the bone-and-joint wards of the Weston Sanatorium 307 patients, of whom it has been possible to follow 296 up to the present time,—a period of from one to ten years. In these 296 cases, 356 lesions of bones, joints, and associated structures were recognized. As the hospital accommodation is chiefly for adults, only twenty-five (8 per cent.) of this group were children under twelve years of age. At the time of admission to the Hospital, the youngest patient was two and one-half years of age, and the oldest seventy years of age,—the majority falling into the age group between fifteen and forty-five years of age. The etiology has been proved bacteriologically in 70 per cent., but roentgenograms, history, and clinical examination have had to be relied upon in the remainder. All cases in which there seemed to be the slightest doubt of tuberculous origin have been excluded. The fact that 20 per cent. of the patients with hip lesions admitted to the Hospital as tuberculous have not been included in this analysis, is an indication of the difficulty experienced in making a certain diagnosis of tuberculous arthritis in many cases. For this reason, every effort is put forth to obtain material for bacteriological culture at the time of the patient's admission to the Hospital, or as soon afterwards as an abscess or effusion is suspected, with the result that an ever-increasing proportion of lesions are being diagnosed with indisputable certainty. In recent years an attempt has been made to differentiate, by cultural meth-

* Read in part at the Annual Meeting of the Canadian Tuberculosis Association at Toronto, Ontario, June 6, 1941.

ods, between bovine and human infections, and up to the present time, no case of bovine tuberculosis has been discovered.

GENERAL RULES OF TREATMENT

Immobilization of the patient and of the affected joints, for a length of time sufficient to permit apparent arrest of the disease as gauged by roentgenographic and clinical findings, and adequate care of any other foci of tuberculosis in the body, are recognized as essential. In a chronic systemic disease like tuberculosis, for which the only adequate treatment known at the present time is *rest*, any other attitude would appear to be short-sighted and productive of mediocre results when reviewed over a long period of time. It is customary to carry out a fusion operation in the weight-bearing joints, some months after the commencement of treatment, when the patient has shown clinical and laboratory evidence of a favorable response to recumbency. In the joints of the upper extremity, a fusion operation has been resorted to only when the patient has complained of pain or weakness in the joint after the arrest of the disease has been brought about by immobilization.

Under this general scheme of treatment, unless the patient declines to be operated upon, or unless he fails to respond to rest therapy, he ultimately undergoes a fusion operation, if the lesion is in the spine, hip, knee, ankle, or foot. The end results in these patients who have been operated upon have been very gratifying, but the rule of advising operation in all suitable cases renders impossible an accurate comparison of these results with those obtained by purely conservative methods in the smaller and less favorable group of patients who either refused operation, or who did not respond to simple immobilization therapy.

FACTORS INFLUENCING PROGNOSIS

To obtain an accurate prognosis in bone and joint tuberculosis as a disease, it is necessary to analyze the results obtained in the entire group of 296 cases, irrespective of the therapeutic measures adopted. When this is done, it becomes apparent that there are several factors which influence the prognosis adversely, and of these, two are of outstanding importance,—namely, the presence of multiple foci of tuberculosis in the body, and the presence of organisms other than tubercle bacilli in any of these foci. The latter condition will be discussed first.

1. *Tuberculous Abscesses and Secondary Infection*

It has been observed, that uncontaminated tuberculous abscesses need not be a source of anxiety so long as the bone lesion is under adequate treatment by immobilization, because the abscess will subside with the regression of the bone lesion. It is the custom here to aspirate all abscesses, using a stringent aseptic technique, in order to relieve symptoms of pressure, to prevent spontaneous rupture through the skin, or simply to obtain material for confirmation of the diagnosis. An abscess is

aspirated at suitable intervals until pus can no longer be obtained. It has been observed that spontaneous bony fusion of a joint is more likely to occur if it is possible to remove by aspiration the pus and necrotic debris which lie between the two joint surfaces and impede the process of ankylosis.

It has also been observed that paraplegia may sometimes be relieved by aspiration of a paravertebral abscess in the thoracic region, a procedure which is most effectively carried out under fluoroscopic control. Abscesses which cannot be kept from perforating, are kept free from contamination after rupture by a moist antiseptic dressing (for example, Keith's dressing of carbolic in glycerine).

From time to time, however, patients are admitted with running sinuses, originating in bones and joints, already contaminated with staphylococcus, streptococcus, or other secondary organisms. The grave prognosis associated with such a complication, especially when it occurs in the spine, sacro-iliac joint, or hip, is too well known to require elaboration. Out of fifty-six cases of Pott's disease, free from tuberculosis elsewhere in the body, there was a mortality rate of 13 per cent. All the patients who died had secondary infections, and all save one, who died of a coronary occlusion, died as a direct result of their secondary infection. By the time they are admitted to the Hospital, many of these patients have suffered such degenerative changes from chronic suppuration, that they cannot tolerate treatment by drugs of the sulphonamide group. Even the encouraging results obtained in this Hospital from the use of sulphathiazole by mouth, combined with its direct application into sinuses, have only partially reduced the probability that a secondarily infected tuberculous bone or joint, unless it can be excised, will ultimately result in amyloidosis and death. This means that contaminated spine lesions in particular carry an exceedingly grave prognosis, because of the impossibility of excising or even saucerizing such lesions. It should perhaps be pointed out that the presence of secondary organisms at the mouth of a sinus does not necessarily mean invasion of the bone from which the sinus arises. It is the invasion of the bone which is catastrophic for the patient.

2. Multiple Lesions of Tuberculosis

One purpose of this report is to demonstrate that patients who have bone and joint lesions are the subjects of disseminated tuberculosis to a degree even greater than is generally suspected. Another purpose is to show to how great an extent this factor influences the prognosis for each individual. That this fact should be emphasized must be admitted, when it is recalled that surgeons still commonly fail to recognize the systemic nature of tuberculosis. There still exists the temptation to treat a tuberculous joint as a localized arthritis, and to overlook the fact that the skeletal lesion is an indication of invasion of the systemic blood stream by tubercle bacilli. On the other hand, recognition of this fact will lead automatically to a careful search for tuberculosis elsewhere in the body. In the group of 296 patients under consideration, tuberculosis was found

in the genito-urinary system in over 20 per cent., elsewhere in the skeleton in 28 per cent., and in the lungs (phthisis) in over 40 per cent. In the group of 59 per cent. showing no roentgenographie evidence of phthisis—active, arrested, or obsolescent—the bone lesions are doubtless the result of the chronic dissemination, through lymph channels and blood vessels, associated with a childhood primary lesion which remained active for a period of time, but ultimately healed. It is probable that the bone lesions in most of the remaining 40 per cent. also were laid down in a similar manner, but a few seem to have arisen late in the course of the disease, from an actively spreading phthisis which dominated the picture. The part played by trauma in adult life, in activating a bone lesion laid down many

TABLE I

INCIDENCE OF TUBERCULOUS COMPLICATIONS IN BONE AND JOINT TUBERCULOSIS
(356 Lesions in 296 Patients Discharged from Weston Sanatorium from 1931 through 1940)

Site of Lesion	No. of Lesions	No Tbc. Comp. (Per Cent.)	Tuberculous Complications Single or Combined			Mortality Rate	
			Pulmon-ary (Per Cent.)	Skeletal (Per Cent.)	Genito-Urinary (Per Cent.)	No Tbc. Comp. (Per Cent.)	Entire Group (Per Cent.)
Spine.....	173	32	37	37	27	13	29
Hip joint.....	51	59	18	26	20	23	31
Sacro-iliac joint..	22	9	82	41	18	0	32
Knee joint.....	32	16	53	47	31	0	25
Ankle and foot joints.....	9	22	33	78	33 [*]	0	22
Shoulder, elbow, wrist, and hand joints.....	30	27	67	40	20	0	43
Clavicle, scapula, os innominatum, femur, tibia, fibula...	11	9	64	73	27	0	36
Tendon sheaths, bursae, soft-tissue abscesses	28	7	68	57	25	0	39
Total lesions....	356	30	44	40	25		
Number of individual patients represented...	296	106	123	85	68	14	85
Percentage of entire group of 296.....	100	35.8	41.6	28.6	23.0	13.2 (of 106)	28.6

years ago in childhood, offers food for considerable thought and speculation.

INCIDENCE OF TUBERCULOUS COMPLICATIONS IN SKELETAL TUBERCULOSIS

At this juncture it will be worth while to emphasize the high incidence of multiple foci of tuberculosis in patients with bone and joint lesions. Accordingly, an analysis of 356 lesions occurring in 296 patients is presented in tabular form. It must be kept in mind that only 296 individuals are represented, although 356 separate lesions are analyzed. The figures at the foot of the table give the incidence in the 296 patients; while the figures opposite each joint give the incidence in all patients having a lesion in that joint.

The lesions chosen for study are the three commonest tuberculous complications of patients who have a tuberculous bone or joint,—namely pulmonary tuberculosis, other tuberculous bones or joints, and genito-urinary tuberculosis. Many patients have all three complications; hence the overlapping of figures in Table I. While some of the groups are too small to have any significance, the larger groups and the totals should have some value. The following points are presented as being of special interest.

1. *Cases without Demonstrable Tuberculous Complications* (35.8 per cent.)

More than one-third of all patients had an isolated lesion of skeletal tuberculosis. No explanation is offered for the comparative freedom of patients with hip-joint lesions from complications (59 per cent.), nor for the rarity of uncomplicated sacro-iliac lesions (9 per cent.). However, attention should be drawn to the frequency with which the latter are associated with phthisis (82 per cent.). The actual mortality rates for the two groups, strangely enough, are practically the same (31 and 32 per cent.), but this is due to the fact that over one-third of the fatalities in patients with hip lesions came from non-tuberculous disease.

2. *Cases Complicated by Pulmonary Tuberculosis* (41.6 per cent.)

Pulmonary tuberculosis is the commonest and most serious of all tuberculous complications of bone and joint lesions. One is impressed by the folly of undertaking to treat a joint lesion in a general hospital without even having a chest roentgenogram made; and yet this used to be a not infrequent procedure. This analysis again places the hip joint in a favorable light, as phthisis (active or arrested) was present in only 18 per cent. of fifty-one cases, as compared with a general incidence of 41 per cent., and an incidence of 82 per cent. of twenty-two patients with sacro-iliac lesions. Pulmonary disease was classified as minimal in 37 per cent., moderately advanced in 36 per cent., and far advanced in 27 per cent. The effect of an active pulmonary lesion on the prognosis will be considered later.

TABLE II
IMMEDIATE CAUSES OF DEATH IN BONE AND JOINT TUBERCULOSIS
(85 Deaths in 296 Discharged Patients)

	No. of Cases	Percentage of Discharges	Percentage of Deaths
Miliary tuberculosis and tuberculous meningitis.....	27	9.1	31.7
Pulmonary tuberculosis.....	22	7.4	25.9
Chronic suppuration in bone tuberculosis (11 with amyloidosis and 5 without amyloidosis).....	16	5.4	18.8
Addison's disease.....	6	2.0	7.1
Renal tuberculosis.....	3	1.0	3.5
Non-tuberculous deaths (including 2 cases of postoperative embolism).....	11	3.7	13.0
Totals.....	85	28.6	100.0

3. Cases with More Than One Focus of Bone Tuberculosis (28.6 per cent.)

This complication may prolong treatment considerably, as well as impair the prospects of the patient's return to work. More than three-fourths of the patients with tuberculosis in the ankle and foot fell into this group, while only about one-fourth of those with hip lesions were subject to this complication.

4. Cases Complicated by Tuberculosis of the Genito-Urinary System (23.0 per cent.)

This complication occurs with considerably greater frequency in patients suffering from multiple bone lesions than in those with a single bone lesion, indicating a wide dissemination of infection following the primary invasion in childhood. In cases of pulmonary tuberculosis without skeletal involvement, the incidence is only 1.75 per cent. The presence of genito-urinary tuberculosis appears to affect the prognosis less seriously than does the presence of pulmonary tuberculosis, or of multiple bone lesions, being a less incapacitating disease. It is of interest to observe that the incidence of genito-urinary tuberculosis varies but little from group to group. Perhaps this is due to the greater certainty with which this complication can be diagnosed by a persistent routine of periodic culture of the urine for tubercle bacilli in all cases of bone and joint tuberculosis.

THE EFFECT OF TUBERCULOUS COMPLICATIONS ON PROGNOSIS

1. Mortality (Tables I, II, and III)

The general mortality rate in the group of 296 patients was 28.6 per cent. As generalized miliary tuberculosis and meningitis are so often

TABLE III
MORTALITY RATE AND CAUSE OF DEATH, GROUPED ACCORDING TO MULTIPLICITY OF LESIONS

Tuberculous Complications of Bone and Joint Lesions	No. of Patients	No. of Deaths	Mortality (Per Cent.)	Immediate Cause of Death (No. of Cases)					Non- Tuberculous Disease
				Meningitis and Miliary Tuberculosis	Pulmonary Tuberculosis	Chronic Suppuration	Addison's Disease	Renal Tuberculosis	
1. Single bone and joint lesion.	106	14	13.2	2	—	8	—	—	4
2. Single bone and joint lesion plus genito-urinary tuberculosis.	24	4	17	—	—	1	1	—	2
Multiple bone and joint lesions.	29	6	21	3	—	1	1	—	1
Multiple bone and joint lesions plus genito-urinary tuberculosis	14	3	21	—	—	1	1	—	1
Total of 2.	67	13	19.4	3	—	3	3	—	4
3. Single bone and joint lesion plus pulmonary tuberculosis.	66	25	38	11	10	2	—	—	2
Multiple bone and joint lesions plus pulmonary tuberculosis.	27	12	44	3	5	2	1	—	1
Single bone and joint lesion plus pulmonary plus genito-urinary tuberculosis.	15	12	80	6	4	—	1	1	—
Multiple bone and joint lesions plus pulmonary plus genito-urinary tuberculosis.	15	9	60	2	3	1	1	2	—
Total of 3.	123	58	47.1	22	22	5	3	3	3
Total of 1, 2, and 3.	296	85	28.6	27	22	16	6	3	11

found in conjunction, they have been grouped together in Table II. This was the immediate cause of death in 9 per cent. of the patients, and thus accounts for nearly one-third of the fatalities,—an incidence much higher than that found in patients with pulmonary tuberculosis without systemic involvement, of whom only 2 to 3 per cent. die from this complication.

Pulmonary tuberculosis was the immediate cause of death in 7.4 per cent. of the patients, and thus accounts for about one-quarter of all deaths. Bone tuberculosis, or chronic suppuration, nearly always due to secondary infection, and usually ending in amyloidosis, caused death in 5.4 per cent. of the patients, thus accounting for almost one-fifth of all deaths. Adrenal tuberculosis was the immediate factor in 2 per cent., and thus exceeds renal tuberculosis (1 per cent.) in importance as a cause of death. Of the three chronic tuberculous complications considered, pulmonary tuberculosis is thus the most serious, bone tuberculosis with suppuration the next, and renal tuberculosis the least frequently fatal.

Non-tuberculous disease resulted in death in 3.7 per cent. of the patients, the commonest cause being coronary occlusion (three cases). Other causes were glomerular nephritis (two), postoperative embolism (two), pericarditis, lobar pneumonia, influenzal pneumonia, and acute pulmonary oedema (one each).

A glance at the last two columns in Table I will show that only fourteen deaths occurred among the 106 patients whose bone and joint lesions were not complicated by tuberculosis elsewhere, a mortality rate of 13.2 per cent. This leaves seventy-one deaths among the 190 patients who had multiple foci, a rate of 37.4 per cent. In the former group the deaths were all of patients with spinal or hip-joint tuberculosis, and more than half of them were due to chronic suppuration, again emphasizing the gravity of secondary infection of bone. These patients would almost certainly have been living today if their abscesses had been treated by aspiration, instead of by incision without adequate antiseptic aftercare.

The rise in the mortality rate, which accompanies the increase in the number of tuberculous foci in a patient, is shown in Table III. The 13 per cent. mortality associated with the single-focus group, rises to between 17 per cent. and 21 per cent. when genito-urinary tuberculosis or when multiple bone foci are added. When pulmonary tuberculosis enters the picture the rate is greatly increased, ranging from 38 per cent. in the most favorable group, to between 60 per cent. and 80 per cent. when genito-urinary and multiple bone foci are present. The pulmonary disease is often more advanced in these latter groups.

The causes for this mortality are shown in the second part of Table III. In the single-lesion group, 86 per cent. of the deaths were due to either chronic suppuration or non-tuberculous disease. In the group with complications but without pulmonary tuberculosis, the immediate cause of death was found to be secondary infection, or non-tuberculous disease slightly more often than tuberculous meningitis or Addison's

disease, indicating that many of these patients survive their tuberculous infection and die of something else. Addison's disease caused as many deaths as chronic suppuration and meningitis or miliary tuberculosis. Renal tuberculosis was not a direct cause of death.

In the group of patients with the complication of pulmonary tuberculosis, the lung focus caused as many deaths as miliary tuberculosis and meningitis, and these two causes of death accounted for three-fourths of the total. The remaining fourth was divided almost evenly between chronic suppuration, Addison's disease, renal tuberculosis (uraemia), and non-tuberculous disease.

The extremely adverse effect of pulmonary tuberculosis should serve as an incentive to search for this complication and to treat it vigorously from the very beginning, rather than to devote so much attention to the joint lesion that the pulmonary one receives scant care.

It is very obvious that meningitis and miliary tuberculosis increase rapidly in incidence with increase in the number of lesions, occurring in less than 2 per cent. of those with a single focus, in less than 5 per cent. of those with non-pulmonary multiple foci, and in 18 per cent. of those with both pulmonary tuberculosis and multiple systemic lesions.

Miliary tuberculosis was not precipitated by surgery in any of these patients, so far as could be ascertained. In one case, it is true, meningitis appeared three weeks after an arthrodesis of the hip joint, but a post-mortem examination of the brain revealed the presence of old tubercles, and miliary tubercles were not found elsewhere in the body. The only other case of meningitis to occur within a year of operation, was in a patient with advanced pulmonary and laryngeal tuberculosis, and his operation was on the spine, so that the actual site of the disease was not disturbed by surgery.

Bone suppuration caused death to approximately the same degree (about 4 per cent.) in both groups with multiple foci, but was nearly twice as frequent a cause of death (7.5 per cent.) in the group without complications, presumably because these patients had, so to speak, a smaller choice of lesions from which to die. How many lives might have been saved if chronic suppuration had been prevented by adequate treatment of abscesses!

2. *Suitability for Operation, Arrest of Disease, and Capacity for Work* (Table IV)

The large group of 173 cases of Pott's disease, when examined in detail, throws considerable light on the effect which multiple foci of tuberculosis in the body have upon the chances of the patient undergoing surgery, of having tuberculosis throughout the body arrested, and of returning to work. The important lesson to be learned from Table IV is that the chance of arresting tuberculosis in the body decreases with the number of systems affected, while the mortality rate rises. It is axiomatic, of course, that the incidence of ability to return to work increases directly

TABLE IV

PROGNOSIS OF POTT'S DISEASE (1 to 10 Years)
 Analysis of Multiple Lesions of Tuberculosis in 173 Patients *
 Followed at Toronto Hospital for Treatment of Tuberculosis, 1931 through 1940

Tuberculous Lesions Combined in One Patient	No. of Patients	Bone-Graft Operation (Per Cent.)	All Lesions Arrested (Per Cent.)	Died (Per Cent.)	Now Working		
					Full Time (Per Cent.)	Part Time (Per Cent.)	Total (Per Cent.)
Spine (isolated lesion)	56	82	80	13	61	16	77
Spine plus pulmonary lesion	28	64	50	32	27	15	42
Spine plus other bone lesion	24	46	38	25	21	17	38
Spine plus genito-urinary lesion	17	76	35	20	17	—	17
Spine plus combined bone and genito-urinary lesions	12	58	25	17	17	—	17
Spine plus combined pulmonary and bone lesions	17	30	12	53	6	6	12
Spine plus combined pulmonary and genito-urinary lesions	8	38	13	75	13	—	13
Spine plus combined pulmonary, bone, and genito-urinary lesions	11	36	18	64	9	—	9
Total	173	60 1 2	46 8	28 6	31 2	11 0	42 2

* All percentages are based on total number of patients in each group.

with the rate of cure, which in turn varies inversely with the number of lesions.

Single Lesion (56 patients). In this group, free from tuberculosis elsewhere in the body, 82 per cent. of the patients with Pott's disease were good operative risks, and in 80 per cent. complete arrest of the disease was achieved. As previously noted, of the 13 per cent. who died, all save one died as a direct result of secondary infection of a cold abscess. At present, 77 per cent. of the fifty-six patients in this group are working, most of them full time, a rate almost double that prevailing (42 per cent.) in the total group of 173 patients with spine lesions.

Pulmonary Lesion (64 patients). Without going into a detailed consideration of the extent of the pulmonary lesion, it is sufficient to say that the presence of pulmonary tuberculosis by itself, even without other tuberculous complications, promptly reduces the operability of the patient by 18 per cent., reduces the cures from 80 per cent. to 50 per cent., increases the death rate from 13 to 32 per cent., and reduces the expectation of return to work from 77 per cent. to 42 per cent. If the pulmonary lesion is associated with other systemic lesions, the chances for healing drop to between 12 per cent. and 18 per cent., the mortality rate rises rapidly to between 53 per cent. and 75 per cent., while the incidence of return to work dwindles to 9 per cent. to 12 per cent.

Bone or Genito-Urinary Lesions (53 cases without and 36 cases with pulmonary lesions). Similarly, the occurrence of either multiple bone lesions, or of genito-urinary tuberculosis, or of both, lowers the expectation of cure, and of a return to work, though not so much as when pulmonary tuberculosis is combined with these lesions. Genito-urinary tuberculosis affects the mortality less than multiple foci in bones. When a patient with Pott's disease has pulmonary and genito-urinary tuberculosis, and multiple bone lesions, his hospitalization must last longer to allow for adequate treatment of each lesion, but his expectation of obtaining arrest of disease in the body is only 18 per cent., and his chance of returning to work, only 9 per cent. In spite of this, bone-grafting of the spine was carried out in 36 per cent., in an endeavor to save the patient from a bed-ridden existence; and occasionally brilliant results were unexpectedly obtained, with permanent healing of all lesions. None of these cases should be abandoned as hopeless, but treatment should be undertaken with the expectation of salvaging a small, but appreciable number.

A similar analysis of the fifty-one patients with hip-joint tuberculosis shows a comparable state of affairs, with 57 per cent. operated on, and 57 per cent. obtaining arrest of tuberculosis in the body in the group without complications, as compared with 50 per cent. operated on and 47 per cent. obtaining arrest in the total group. The mortality rate for the latter was 31 per cent., and 47 per cent. are now working, as compared with a mortality of 28 per cent., and a return to work of 42 per cent. in the entire group with Pott's disease.

In knee-joint tuberculosis the difference in prognosis for those with a

TABLE V

SPINE BONE-GRAFTING FOR POTT'S DISEASE

End Results in the First 100 Consecutive Patients Followed at the Toronto Hospital for the Treatment of Tuberculosis, 1931 through 1940

Pott's Disease Arrested.....	88 per cent.
Patients working full time.....	50
No evidence of active tuberculosis in the body.....	46
Required subsequent operation for hip.....	1
Evidence of quiescent tuberculosis of lung or knee.....	2
Required subsequent grafting for new lesions.....	1
Working part time.....	14
No evidence of active tuberculosis in body.....	12
Required second hospitalization.....	2
Unemployed because of.....	9
Recent discharge from Hospital.....	6
Disability from healed pulmonary tuberculosis.....	2
Disability from unstable tuberculous hip.....	1
Still require hospital treatment, for.....	8
Tuberculosis of hip.....	3
Tuberculosis of other bones or joints.....	3
Renal tuberculosis or persistent paraplegia.....	2
Died after discharge from Hospital.....	7
Miliary tuberculosis and meningitis.....	1
Pulmonary tuberculosis.....	1
Renal tuberculosis.....	1
Addison's disease.....	2
Non-tuberculous pulmonary disease.....	2
Pott's Disease Not Arrested.....	12 per cent.
Due to spine fusion in unstable position.....	2
Recurrence in or adjacent to original site.....	5
Death during treatment.....	5
Secondary infection of spine after operation followed by amyloidosis.....	1
Addison's disease.....	1
Miliary tuberculosis and meningitis.....	3

single lesion, and those with tuberculous complications is even greater. One hundred per cent. of the patients without complications are now working, while in the entire group of thirty-two patients only 44 per cent. are back at work, the difference being due to the disabling effects of some types of tuberculous complications.

3. *Effect of Tuberculous Complications in Cases of Bone Graft (Table V)*

Finally, the effect of tuberculous complications on the prognosis for patients whose condition has been good enough to permit a bone-graft operation on the spine, is illustrated in Table V, which shows the end result in the first 100 consecutive patients who have been discharged and followed for one to ten years, and whose condition at the present time has been ascertained by examination.

The 100 cases include nearly all the patients without complications, and many of those with various tuberculous complications. Pott's

disease was arrested in eighty-eight, but only sixty-four of the 100 are now working, and a careful inspection of Table V shows that even among those now working, recovery was delayed in six by multiple lesions. Twenty-four of the eighty-eight patients with arrested Pott's disease are not working. Among these, nine are living at home and three of them have no prospect of becoming employed, because of tuberculosis elsewhere. Eight others still require hospital treatment for tuberculosis elsewhere, although their Pott's disease has been arrested. Seven died after being discharged as cases of arrested Pott's disease, five of them from tuberculosis elsewhere in the body. In four of the twelve whose tuberculosis of the spine was not arrested, the unfavorable result was due to tuberculosis elsewhere. Thus, even in this selected group of 100 cases of bone-grafting, a favorable outcome was delayed or prevented in twenty-six by the presence of tuberculous complications.

It would, however, be unfortunate to leave the impression that it is not worth while spending time on patients suffering from multiple foci of tuberculosis. If all lesions are treated individually and vigorously, and if the patient is kept at adequate rest, the results in many cases will be astonishingly good, and often of long duration and perhaps permanent. The results obtained by surgical ankylosis of the involved joints have been very impressive; bony fusion is promoted in this way more certainly and usually more quickly than by immobilization without surgery. The fibrous ankylosis, which is often the best result to be hoped for without surgery, rarely gives a patient the same sense of security and of ability to undertake hard work, as does bony ankylosis. Surgery also either entirely removes, or permanently and completely immobilizes a lesion which would otherwise be only a quiescent and unprotected one. Surgery can be carried out with safety after control of the pulmonary lesion has been secured by any of the numerous methods at the disposal of phthisiologists and thoracic surgeons today, and the desired ankylosis of bone obtained with a greater degree of certainty if the surgery is delayed until all tuberculosis throughout the individual is under control.

CONCLUSIONS

1. Bovine tuberculosis is no longer a factor of any significance in the causation of bone and joint tuberculosis among adults in Ontario.
2. Adequate treatment of bone and joint tuberculosis demands adequate provision for rest as well as adequate provision for surgery.
3. Prognosis is affected favorably by two factors in particular:
 - (a) Adequate treatment of abscesses, so as to prevent secondary infection of bone,—the existence of an uncontaminated tuberculous abscess need not affect the prognosis adversely.
 - (b) Freedom from multiple lesions of tuberculosis in the body.
4. Secondary infection of various joints has the following effects:
 - (a) Of the spine renders the prognosis almost hopeless;
 - (b) Of the sacro-iliac joint and hip renders the prognosis poor;

- (c) Of the knee, ankle, or foot requires excision or amputation;
- (d) Of the joints of the upper extremity greatly prolongs hospitalization.

5. Multiple lesions of tuberculosis are to be found in a high proportion of cases, as follows:

- (a) Pulmonary tuberculosis in over 40 per cent.
- (b) Multiple bone tuberculosis in almost 30 per cent.
- (c) Genito-urinary tuberculosis in over 20 per cent.

The prognosis is affected adversely by the presence of these complications, their importance being in the order named.

6. More than one-third of all patients were free from multiple tuberculous foci. The percentage of arrested disease and the ability to return to work in these patients was high, especially in the cases of tuberculosis of the spine (80 per cent.) and of the knee (100 per cent.). The mortality rate was 13 per cent. and was usually due to secondary infection of bone, or to non-tuberculous disease.

7. Almost one-quarter of all patients had additional tuberculosis in other bones, or in the genito-urinary system, or in both, but not in the lungs. In these, the treatment has to be long enough to arrest tuberculosis throughout the body, and more than one operation is usually required. The incidence of return to work is much reduced and the mortality rate rises to about 20 per cent., due to the appearance of meningitis and of Addison's disease in addition to chronic suppuration and non-tuberculous disease.

8. Over 40 per cent. of all patients had pulmonary tuberculosis, the most serious of tuberculous complications. When this is combined with other skeletal and renal foci the prognosis is very much worse than when pulmonary tuberculosis is the only complication, the incidence of arrested disease and of return to work in the latter being between 40 and 50 per cent., and in the former between 12 and 20 per cent. The mortality rate rises from 38 per cent. in the latter to between 44 and 80 per cent. in the former, the outstanding causes being miliary tuberculosis, meningitis, and pulmonary tuberculosis.

9. Tuberculosis of the spine was arrested in 88 per cent. of patients treated by spine bone graft, but in 26 per cent. the arrest of the systemic disease was delayed or entirely prevented by tuberculosis elsewhere in the body.

10. The best results are to be obtained by treating bone and joint tuberculosis first by rest and by controlling other tuberculous foci in the body; then by operation to secure bony ankylosis of the affected joint, because the results following this are superior to those obtained by the fibrous ankylosis or unstable joints which so often mark the end result of non-surgical treatment.

HIP-JOINT INVOLVEMENT IN GAUCHER'S DISEASE

BY ALBERT J. SCHEIN, M.D., AND ALVIN M. ARKIN, M.D., NEW YORK, N. Y.

*From the Orthopaedic Service of the Mount Sinai Hospital, New York **

Gaucher's disease was first described in 1882 by the man who gave his name to the condition. He thought it was a neoplasm. Subsequently, it was found to be a rare, familial disorder of lipid metabolism, characterized by the deposition of kersin in the reticulum cells of the reticulo-endothelial system. These cells take on a typical appearance, and are called Gaucher cells. The disease is largely, though not entirely, confined to Jewish patients. Symptoms occur most often in childhood and adolescence, but, because of its chronicity and slow progression, its victims may live a fairly normal life for many years. In several of the authors' cases, the diagnosis was not established until well on in adult life.

Any part of the reticulo-endothelial system may be involved, but the spleen, liver, lymph nodes, and bone marrow are most commonly affected. The bone changes were first described from the gross pathological viewpoint comparatively recently (1922) by Pick. In 1926, Cushing and Stout reported a woman, thirty-three years old, who complained of pain and stiffness of one hip. Roentgenograms showed marked collapse of the acetabulum and upper end of the femur. Bone sections, removed at operation, showed the typical infiltration of bone trabeculae by Gaucher cells. This was the first reported case with roentgenographic evidence of bone or joint involvement, and the only one in the entire literature on Gaucher's disease in which surgery was done in the hip. Several other patients with involvement of the long bones have had operations after a diagnosis of osteomyelitis.

Welt, Rosenthal, and Oppenheimer in 1929, and Reiss and Kato in 1932, discussed the bone lesions of this disease in detail, and reviewed the literature preceding their papers. In three out of the six cases reported by the former, hip-joint changes had occurred. The latter stressed the hip-joint changes in their cases and in others taken from the literature. Since 1932, additional cases with evidence of hip-joint involvement have been reported by Pachman; Melamed and Chester; Bloem, Groen, and Postma; de Lange; and Determann. In all, sixteen cases with roentgenographic evidence of hip-joint involvement have been reported in the literature.

It is the purpose of this paper to review and attempt to classify these bone changes as they involve the hip joint, and to add eight additional cases. All the skeletal changes are attributable to the infiltration and replacement of the bone trabeculae by kersin-bearing, reticulum cells. These lesions appear on roentgenograms as translucent or more radio-transparent areas, and account for the characteristic mottling. The

* Services of Robert K. Lippman, M.D., and the late Seth Selig, M.D.

fusiform expansion of the lower femur with thinning of the cortex was first described by Welt, Rosenthal, and Oppenheimer as typical of Gaucher's disease.

Under the influence of weight-bearing, several changes, besides the infiltration and mottling, may appear. Collapse and aseptic necrosis of the femoral head with absorption of the acetabulum³ may be noted. Infiltration and thickening of the neck of the femur with coxa vara formation have been described by several investigators. In children, the resemblance of this lesion to chronic osteomyelitis, tuberculous coxitis, and Legg-Perthes disease has been noted by Reiss and Kato. These observers also mention the occurrence of pathological fracture in the neck of the femur, as well as in other long bones. Late osteo-arthritic manifestations appear in the case reported by Determann.

The authors present eight cases of Gaucher's disease with various types of hip-joint involvement. At the Mount Sinai Hospital, on the ward services, from 1933 to 1941, the diagnosis of Gaucher's disease was verified in nineteen cases. All but one of the patients with hip lesions were taken from this group. The patient in Case 6 is from the practice of the late Seth Selig, M.D., and is the brother of the patient in Case 4. Eight out of twenty, or 40 per cent. of the patients had hip lesions. This is second in frequency only to changes in the lower femoral shaft, the latter occurring in about two-thirds of the cases. The authors' cases (as well as those from the literature) have been classified into the following groups:

A. *Hip Lesions in Children*

1. Lesions of the femoral head, usually suggesting Legg-Perthes disease or early tuberculous coxitis (Cases 1 and 2);
2. Lesions of the femoral neck (Case 3) with:
 - a. Simple infiltrative roentgenographic changes,
 - b. Pathological fracture of the neck,
 - c. Coxa vara deformity, with broadening and irregularity of the epiphyseal line, suggesting epiphysiolysis, which might be secondary to simple infiltrative changes or pathological fractures of the neck.

B. *Hip Lesions in Adults*

1. Osteo-arthritic symptoms and signs, probably secondary to childhood lesions of any of the above types (Cases 4, 5, and 6);
2. Roentgenographic evidence of similar changes in patients with Gaucher's disease, usually in young adults, but without any symptoms or signs pointing to the hip. It is likely that, in time, this group may develop symptoms of osteo-arthritis (Cases 7 and 8).

Although the onset is often associated with intermittent pain in various bones and joints, and low-grade fever, the diagnosis can be made only by recognizing the underlying Gaucher's disease, as well as the local condition. The presence of splenomegalia, hepatomegalia, secondary

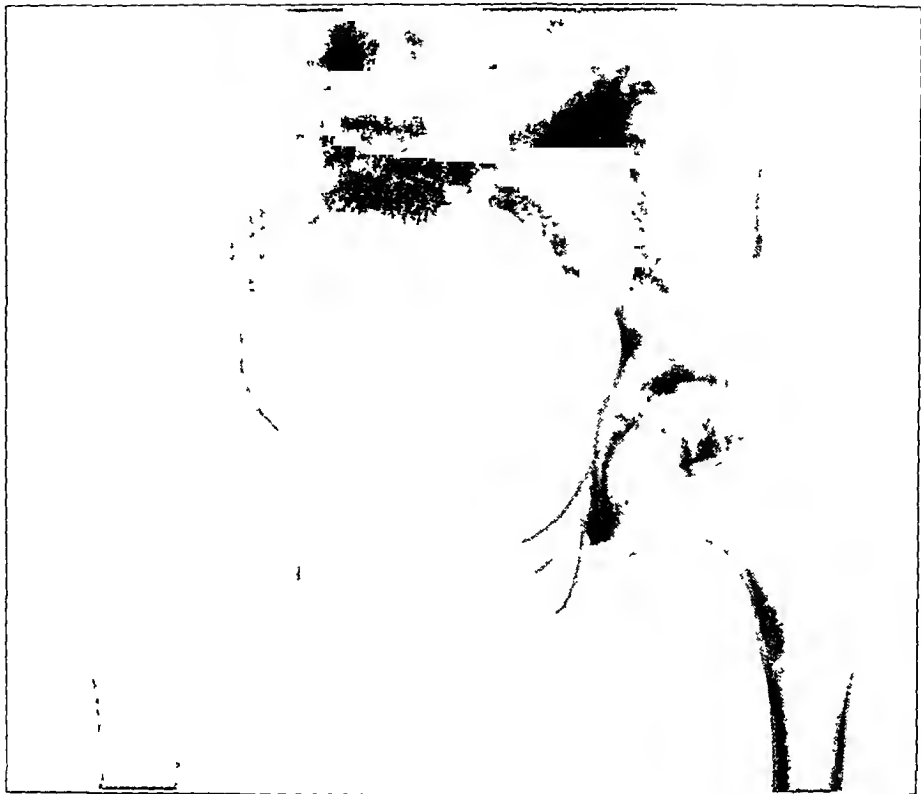


FIG. 1-A

Case 1 M D May 9, 1940. Perthes-like changes in the left hip.

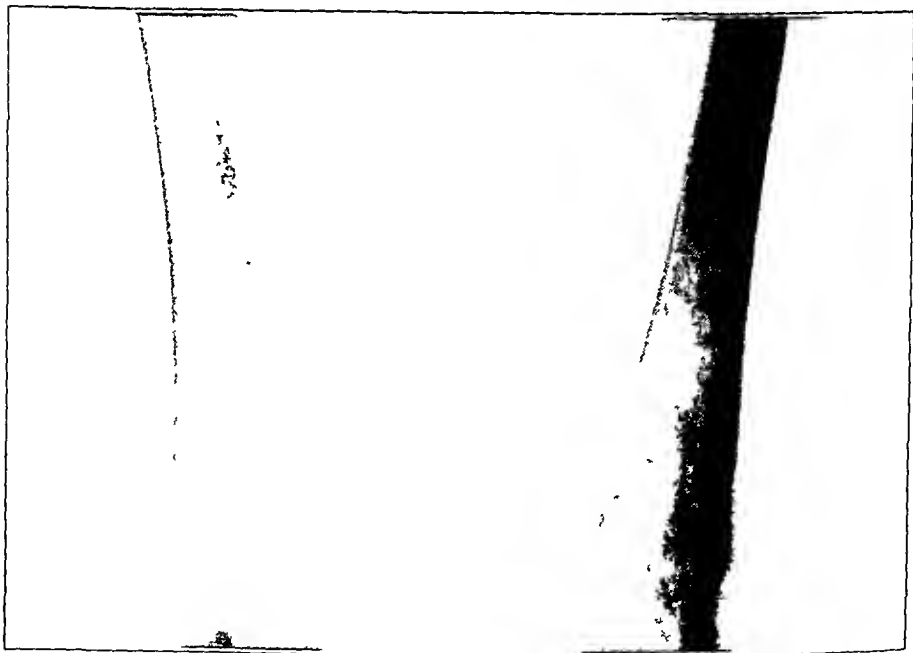


FIG. 1-B

Case 1. M. D. May 9, 1940. Infiltration and expansion of lower femora



FIG. 1-C

Case 1. M. D. September 14, 1941. Regeneration of capital epiphysis (Compare with Fig. 1-A).

anaemia, often with slight leukopenia and thrombocytopenia, hemorrhages, and brown pigmentation of the skin, is of importance. Once the disease is suspected, it can nearly always be confirmed or ruled out by the relatively simple procedure of puncture of the sternal bone marrow. The pathologist can easily identify the large typical cells in the aspirated material. The finding of these cells confirms the diagnosis. Aspiration of the spleen and splenectomy are both unnecessary. Roentgenographic changes in the lower femora are also typical.

The disease in general, as well as its bone lesions, is chronic, lasting for many years. Symptoms may occur at intervals, but there are often free periods in spite of persistent pathology. Very little can be found in the literature about the therapy of skeletal manifestations of Gaucher's disease. For the orthopaedic aspect, the authors have treated their patients with some form of rest during periods of acute symptoms, and in children, for a prolonged period thereafter. Depending on the severity of the disease, simple bed rest, traction, or immobilization in a hip spica may be indicated. Especially in childhood, prolonged rest is considered indicated, as it is in coxa plana, to minimize deformity in what is apparently a vulnerable period of hip-joint growth. While the follow-up period is hardly adequate to prove the benefit of such immobilization, in Cases 1 and 3 definite healing appears to have taken place. In the

former, regeneration of an approximately normal femoral head appears to be taking place as in Legg-Perthes disease, while in the latter, a pathological fracture healed with excellent restoration of bone structure, although with some coxa vara deformity. Both cases are still under treatment by rest, so that the final result is not yet evident.

It is known that the more the structure of a hip deviates from the normal, the more likely is the early onset of osteo-arthritis, which may ultimately become very severe. Once this has developed, disability is inevitable. Cushing and Stout have reported the only instance of surgical therapy in a Gaucher hip joint. This patient, a woman, thirty-three years old, had a resection of the femoral head and neck, and removal of six loose "sequestra" from the partly destroyed acetabular wall. In spite of her anaemia, she made an uneventful recovery from the operation, although there was no long follow-up. In at least one of the authors' cases (Case 5) surgery on the hip joint was seriously contemplated. Hematological study revealed leukopenia and thrombocytopenia. It was then thought that arthrodesis, which was the operation of choice, was unlikely to succeed and that hemorrhagic complications were likely. Apart from surgery, physiotherapy and roentgen therapy have proved ineffective. Rest in recumbency, with traction, has given at least temporary relief in adults and children alike.

REPORT OF CASES

A. *Hip Lesions in Children*

CASE 1. M.D. (Hospital No. 447461), a German-Jewish girl, was ten years of age when admitted to the Mount Sinai Hospital on October 18, 1939. She complained of pain in the left knee and hip of six weeks' duration. A similar attack had occurred one year before and was associated with low fever and a limp. It had been called "periostitis" in Germany where she then was, and she had recovered in two weeks.

Examination showed tenderness of the left knee; restriction of motion of the left hip in all directions, enlarged liver and spleen, and normal temperature.

A puncture of the sternal-bone marrow had been done in the Out-Patient Department, and Gaucher cells were found. Roentgenographic examination (Figs. 1-A and 1-B) of the femora showed irregular areas of rarefaction in the medullary cavity of the left femur in its lower half, and a distinct tendency toward clubbing of the lower ends of both femora. There was a marked deformity of outline.

A sister also had a positive sternal marrow loaded with Gaucher cells, but showed no bone lesions either clinically or by roentgenogram.

The course of this case thus far has resembled very much Legg-Perthes disease of the hip. She improved rapidly with bed rest. A caliper brace was fitted to relieve weight-bearing as much as possible. Roentgenographic examination in September 1941 showed definite, though partial, restitution of the structure and appearance of the head. Some deformity of a coxa plana type persisted (Fig. 1-C). She has been kept at partial or complete rest up to date in the Blythedale Home and Hospital for Convalescent Crippled Children. As relatively normal appearance of the head is noted, full weight-bearing will be allowed.

CASE 2. M. S. (Hospital No. 448304), a German-Jewish girl was ten years old when first seen at the Mount Sinai Hospital on November 25, 1939, with a complaint of pain in the left thigh on walking, of three months' duration. She was first seen at another hospital on October 1, 1938, for limp and pain in the right knee and thigh. Roentgenographic examination of the femora at that time was said to be negative, but spleno-



FIG. 2

Case 2. M. S. November 2, 1939. Infiltration of left femoral head.

megalia had been noted. Symptoms subsided with bed rest. In a subsequent admission in April 1939, the diagnosis of Gaucher's disease had been established by splenic puncture, and splenectomy had been done.

On admission to Mount Sinai, tenderness and slight restriction of motion of the left hip was noted. Roentgenographic examination showed an infiltration with mottling of the upper portion of the left femoral head, like an atypical Legg-Perthes disease (Fig. 2). An eosinophilia of 7 per cent. was also noted.

Pain promptly disappeared with bed rest. A caliper brace was suggested, but before it could be obtained, recovery was so complete that it was omitted. Reexamination four months later revealed no further symptoms or signs related to the bones, and an excellent general condition. She then moved out of town so that further follow-up was impossible.

CASE 3. E. K. (Hospital No. 472130), a Jewish boy had a series of admissions to the Mount Sinai Hospital, beginning in February 1938, at the age of five. His presenting symptom was pain in the lower part of the right femur following a fall. Similar pain had previously been present without injury.

On admission, his temperature was elevated to 101 degrees. There was some restriction of motion in the right knee and tenderness over the lower femur. An enlarged spleen and eosinophilia of 10 per cent. were present, but the diagnosis was not made. Roentgenographic examination was negative. Prompt recovery occurred with bed rest.

He was readmitted in September 1938 for restudy. The liver and spleen were now both enlarged. A sternal puncture revealed typical Gaucher cells in the bone marrow. Roentgenographic examination of the skull and femora showed no changes. In December 1938, he developed a limp in his right lower extremity, with pain on walking, and with no known injury. Roentgenographic study at that time showed a pathological infraction of the neck of the right femur with coxa vara deformity (Fig. 3-A.) There was

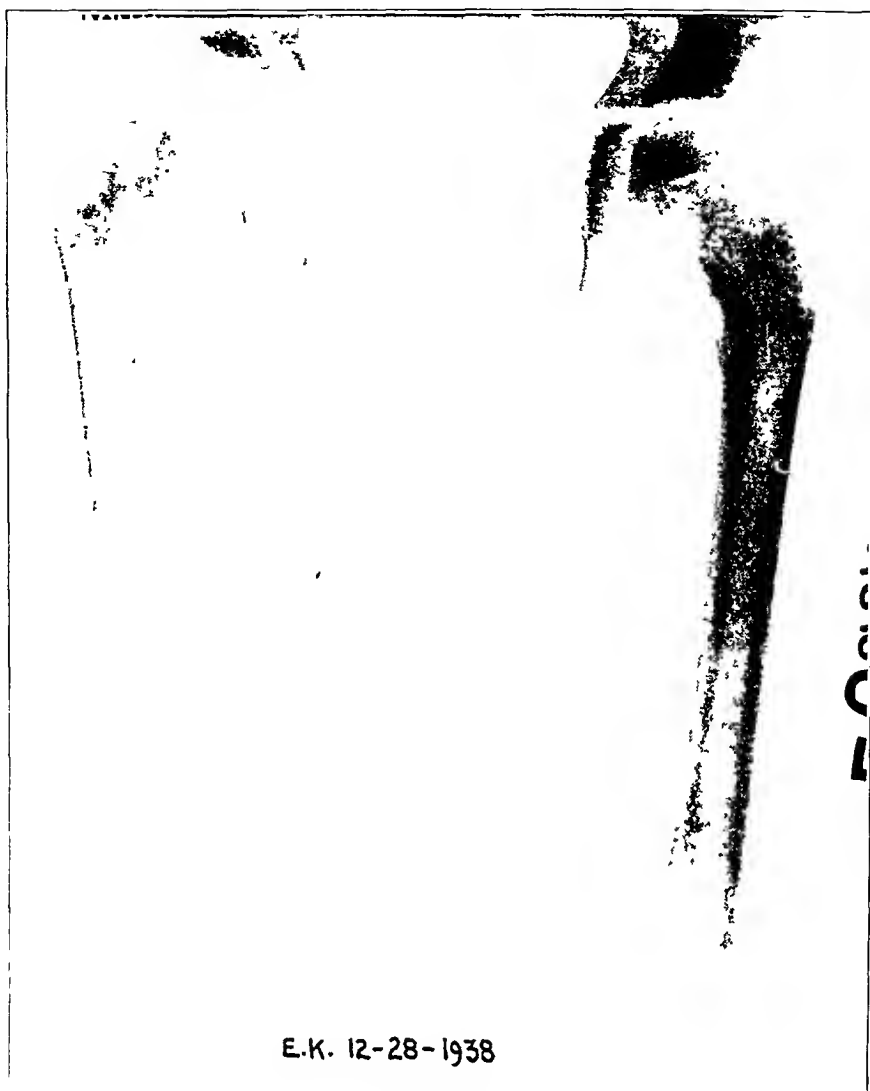


FIG. 3-A

Case 3 E. K. December 28, 1938. Pathological fracture of right femoral neck.

also medullary mottling at the lower ends of both femora. Symptoms of pain in the hip and both knees continued intermittently until he was readmitted in December 1940. At that time the only additional findings were an increased phosphatase, 37 King-Armstrong units, and a persistent eosinophilia. Roentgenograms showed some progression of the lesions of the bones.

In April 1941, he was again admitted for pain in the right hip and inability to walk, of one week's duration. There was again an elevated temperature (102 degrees), marked spasm of the right-hip muscles, and tenderness over the anterior and lateral aspect of the joint. An inflammatory lesion was suspected in addition to Gaucher's disease. Roentgenographic examination showed marked coxa vara, but the epiphysis of the femoral head was undisturbed. Atrophy of the right pelvic bones was present (Fig. 3-B). Traction was applied and brought prompt relief of pain. The temperature gradually became normal. He was discharged to the Blythedale Home and Hospital for Convalescent Crippled Children for a further period of rest and limited weight-bearing. While there, it was deemed advisable to apply a hip spica for further immobilization.

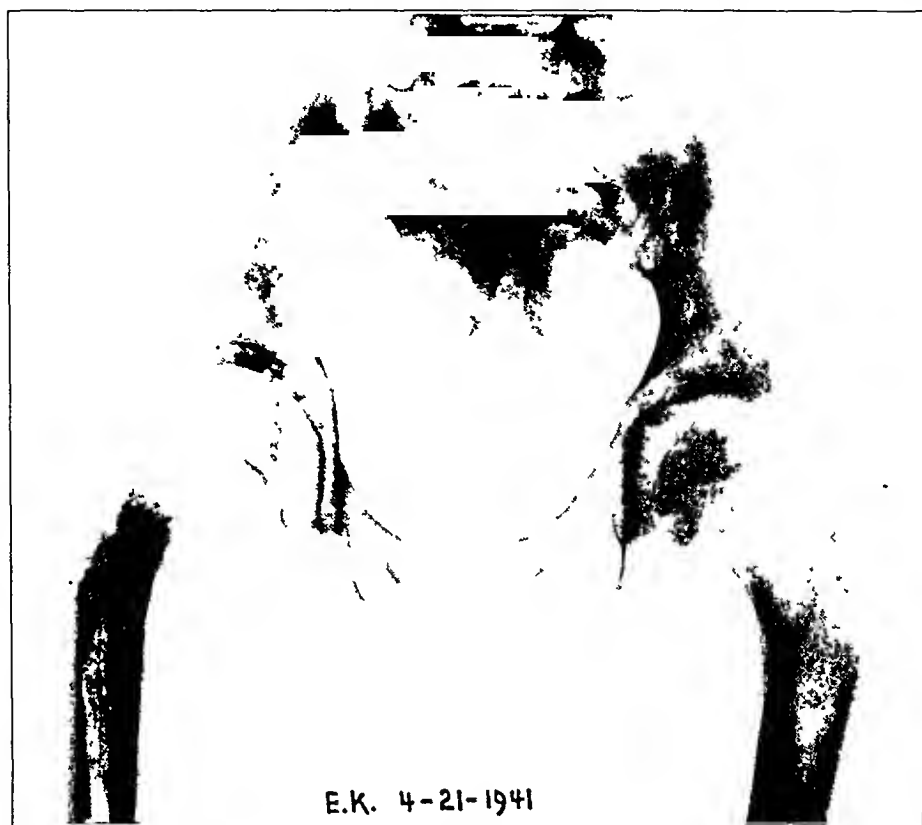


FIG. 3-B

Case 3. E. K. April 21, 1941. Healed pathological fracture with coxa vara.

The final admission to Mount Sinai was in September 1941. Roentgenographic study at this time showed the same diffuse bone changes previously observed, and typical of Gaucher's disease. Persistent coxa vara was present, but there was no sign of the previous femoral neck infraction, and there was no epiphyseal change. Gradual mobilization and weight-bearing were then instituted.

B. *Hip Lesions in Adults.*

CASE 4. A. R. (Out-Patient No. 40-5471), a woman, thirty-two years old, and a deaf mute, came to the Dispensary complaining of pain in the left hip. There was a history of splenomegalia treated at another hospital. In May 1939, splenectomy had been done, and the pathological diagnosis of Gaucher's disease was made. Her hip symptoms were rather mild, and caused little interference with activity. A limp had been present since childhood, but the hip pain was said to be of a few months' duration. At the age of ten, she had had a plaster cast on the right hip for a period of two and one-half years for "Legg-Perthes" disease.

She limped on the right lower extremity, and motions of the right hip were all somewhat restricted. There was no shortening, but one inch of atrophy of the right thigh was present.

Roentgenographic examination in September 1940 (Fig. 4) showed a mushroom deformity of the head of the right femur with coxa vara deformity. The femoral neck was shortened and widened. Both the femoral head and the acetabulum were irregular, and there was a marked coarsening of the trabecular structure in the upper end of both femora. Roentgenograms of the long bones showed areas of rarefaction up to one and



FIG. 4

Case 4 A. R. September 11, 1940. Deformity of left hip with mild symptoms in an adult

five-tenths centimeters in diameter in both shafts of the femora, tibiae, and humeri. There was general decalcification of all the bones, and clubbing of the lower ends of both femora. While the hip changes resembled osteo-arthritis superimposed on an old condition of coxa plana, they were considered typical of Gaucher's disease in the bones.

CASE 5. F. K. (Hospital No. 447741), a Jewish woman, was thirty-two years of age when first treated at the Mount Sinai Hospital in 1929. At that time she complained of pain in the left thigh of four years' duration, as well as of frequent nosebleeds.

Physical findings at that time included splenomegalia, bilateral pingueculae, and hepatomegalia. There was restriction of motion of the left hip and shortening of one and one-half inches in the left lower extremity.

Roentgenographic examination revealed expansion of the lower portion of the shaft of the femora with thinning of the cortex. There was marked irregularity and absorption of the head and neck of the left femur (Fig. 5).

Since that time, the patient has had more or less constant pain in the left hip, severe enough to cause much disability and to necessitate several hospital admissions. In March 1937, roentgenographic examination showed marked deformity of the left femoral head with mushrooming as well as widening of the femoral neck (Fig. 5). The hip-joint space was narrowed, and there were definite osteo-arthritic manifestations. Slight motting of the neck and upper femoral shaft was present, as well as typical clubbing of the lower end of the femur. A flexion-adduction contracture gradually developed, with limitation of motion in all directions. The clinical picture resembled ordinary osteo-arthritis. At various times, physiotherapy, radiotherapy, and bed rest with weight traction were administered. Only the latter seemed to produce any benefit, and even then the pain tended to recur with undue activity. In 1937 also, the diagnosis was finally confirmed by puncture of the sternal bone marrow, which revealed the typical Gaucher cells.

Surgical arthrodesis of the hip was seriously considered, but the Hematology Department advised against this in view of the presence of thrombocytopenia and leuko-

penia, and the possibility of hemorrhagic complications. After this admission in 1937, a Thomas caliper tuber seat brace was applied and gave relief for a considerable period. In January 1941, the patient's activity was much restricted by pain, but she no longer required the brace. Further roentgenographic examinations showed little or no change in the condition of the hip.

CASE 6. L. R. (Courtesy of the late Seth Selig, M.D.), male, was first seen in 1939, at the age of twenty-nine. He is the brother of the patient in Case 4. He had had intermittent pain and swelling about the left knee for some years, with a rather persistent limp. In the year before, increased pain and limp in the left hip were present. At the first examination, there was tenderness over the lateral aspect of the left hip. A flexion contracture of the hip at 135 degrees was present, with limited abduction, adduction, and rotation.

Roentgenograms showed a distortion of the left femoral head, which was elongated and flattened. The medial half was cystic, but the joint space and acetabulum were relatively normal. The diagnoses of old tuberculosis, old Legg-Perthes disease, or old slipped femoral epiphysis were suggested.

With no treatment but bed rest, the symptoms gradually subsided, leaving only slight limitation of extension, abduction, and rotation of the hip. Fusion of the hip had been considered elsewhere, but had been refused by the patient.

In October 1941, the patient returned for further examination. By this time, the authors were aware of the findings in his sister, Case 4, and recognized Gaucher's disease as the underlying cause of the hip lesion. The man was somewhat pallid, and his skin and mucous membranes were subicteric. The spleen was enlarged to four fingers below the costal margin. Further roentgenographic study of the lower femora showed the typical

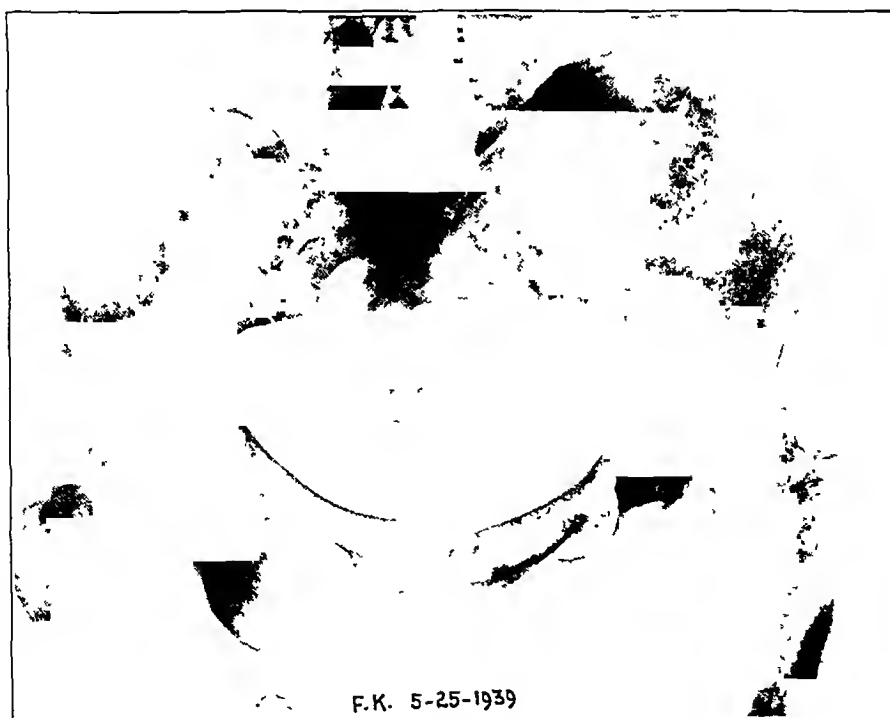


FIG. 5

Case 5. F. K. May 25, 1939. Collapse of left femoral head with marked osteoarthritic symptoms.

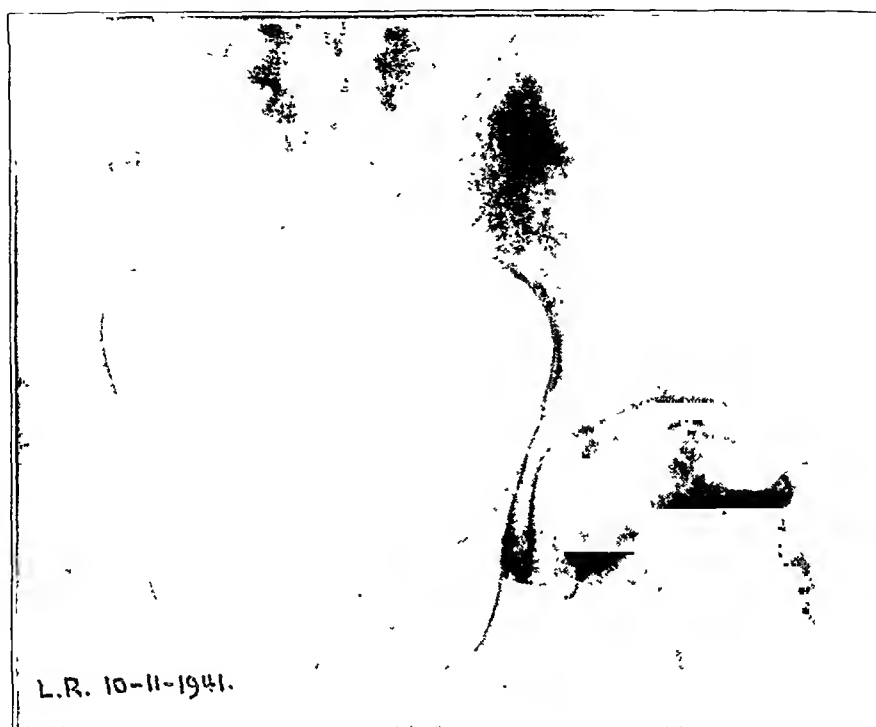


FIG. 6

Case 6. L. R. October 11, 1941. Deformity of femoral head and coxa vara in adult hip. Marked osteo-arthritic symptoms.



FIG. 7

Case 7. F. R. December 2, 1937. Bilateral distortion of femoral heads with coxa vara in young adult. No symptoms as yet.



FIG. 8-A

Case 8. Bilateral deformities of the femoral head with coxa vara.

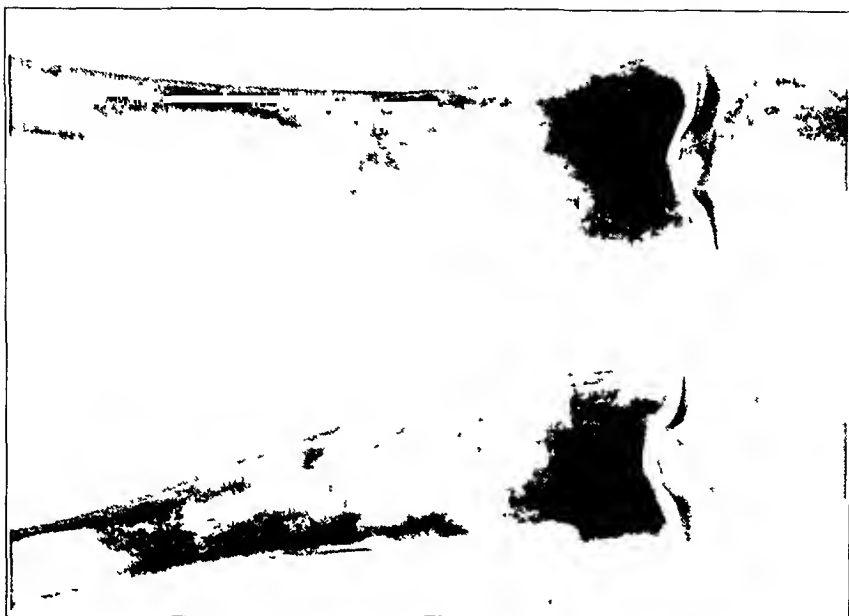


FIG. 8-B

Case 8. Characteristic lower femoral changes (post-mortem specimen).



FIG. 8-C

Case 8. Collapse of the vertebrae with kyphosis.

ting were present in the lower ends of both femora. The leg deformity was corrected somewhat under anaesthesia, and the fracture was treated in a plaster cast. After prolonged plaster fixation, it gradually united with persistent bowing, union being firm only in May 1935.

Roentgenographic examination in December 1937 revealed the changes described previously. There was clubbing of the lower ends of the femora, and still marked flattening of the femoral heads with coxa vara deformity (Fig. 7). No symptoms or signs of hip involvement were noted at this time nor have any developed since. At her last examination in 1941, this patient was asymptomatic, working, walked without limp, and had full range of motion in both hips. Slight persistent bowing of the left leg was still noticeable. In this girl, the hip involvement is so far of minor clinical importance. She is still young and future disability may develop.

changes of Gaucher's disease, with clubbing, thinning of the cortex, and infiltration of the medulla. The hip joint presented the same appearance as before (Fig. 6).

This is the only case not verified pathologically.

CASE 7. F. R. (Hospital No. 417222). A Jewish girl was first admitted to the Mount Sinai Hospital in 1923, when she was three and one-half years old. The presenting complaints were prominence of the abdomen, and epistaxis. An enlarged spleen and liver, and purpura were found. All roentgenographic findings were normal. A splenectomy was done, and the pathological diagnosis was Gaucher's disease.

Her next admission was in March 1934, when she complained of pain and swelling of the left knee of seven years' duration. There was also occasional pain in the left hip. The left knee was enlarged by periarticular thickening, and widening of the upper end of the tibia and fibula. There was outward bowing of the leg at its upper end. Roentgenograms showed a transverse, pathological fracture of the left tibia two inches distal to the knee joint. In the hips, there was marked mushrooming of the femoral heads with coxa vara deformity on both sides. Areas of transparency and mot-

CASE 8. S. F. (Reported in detail by Melamed and Chester). In this Jewish male, symptoms of "arthritis", involving many joints, first developed in 1921, at the age of twelve. Splenomegalia, failure to gain weight properly, and anaemia gradually appeared. In 1922, diagnosis of Gaucher's disease was made by splenic puncture. Four years later, nasal and oral hemorrhages took place, and splenectomy was performed. In 1928, there was a recurrence of joint pains. By 1930, spinal pain and deformity (gibbus) were marked, and there was a considerable decrease in the height of the trunk. Marked hepatic enlargement had occurred together with abdominal pressure symptoms. Collapse of several thoracic vertebrae were demonstrated in 1931.

On his final admission, he was poorly developed, anaemic, and had typical pingueculae. The lymph nodes in the neck, axilla, and groin were enlarged. A marked thoracic kyphosis with compensatory lumbar lordosis was present, as well as a huge liver. Generalized bone tenderness was present, but no definite symptoms or signs relating to specific joints were noted.

Blood studies showed a marked secondary anaemia. Biopsy of an axillary lymph node showed it to be full of Gaucher cells.

Roentgenographic study showed numerous collapsed vertebrae (Fig. 8-C). The pelvis showed cystic changes in the innominate bones, especially near the acetabulum and bodies of the pubis. The femoral heads were flattened and irregularly mushroomed. Cystic changes were present throughout the heads and shafts with broadening of the latter (Fig. 8-A). The lower ends of the femoral shafts showed the typical clubbing or bottle shape (Fig. 8-B). Other less marked changes were present in the right fibula and tibia, as well as in the left radius and right humerus.

Postmortem examination showed the osseous type of Gaucher's disease. There was involvement of the lymph nodes, liver, spinal column, femora, pelvis, right humerus, left radius. Heterotopic bone-marrow formation was found in the liver.

In this patient, the hip changes were only incidental and gave rise to no symptoms or signs. It is likely that the extensive involvement of the bones resulted from the removal of the spleen in early life.

SUMMARY AND CONCLUSIONS

From a study of eight cases of Gaucher's disease with hip-joint involvement, classified on the basis of age group and roentgenograms, it appears that treatment by prolonged rest is indicated to minimize deformity in the patient in the younger age group.

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THE TOCOPHEROLS (VITAMIN E) IN THE TREATMENT OF PRIMARY FIBROSITIS

BY CHARLES LEROY STEINBERG, B.S., M.D., ROCHESTER, NEW YORK

From the Rochester General Hospital, Rochester

William Balfour, an Edinburgh practitioner, first described the occurrence of fibrous thickenings in chronic muscular rheumatism in 1816. On this subject he wrote a book, in which he described numerous nodular tumors and fibrous thickenings which were painful on pressure and which caused referred pain. The term fibrositis was coined by Gowers almost 100 years later (1904). Stockman²³ described the pathology of fibrositis in the same year, although he failed to differentiate between the pathology of primary and secondary fibrositis in this description. Llewellyn and Jones wrote a book on fibrositis in 1915. Stockman²⁴ wrote several excellent chapters on fibrositis, panniculitis, and Dupuytren's contracture in his book "Rheumatism and Arthritis" which was published in 1920. In England, Telling stressed the clinical importance of fibrositis in general practice in 1935, and Slocumb brought its attention to the American physician in 1936.

Kelchner's definition of fibrositis, which was taken from Stockman²⁴, is all-embracing. He states, "Fibrositis is a rheumatoid disorder characterized by a non-suppurative inflammatory reaction in the white fibrous connective tissue, anywhere in the body, with a swelling and proliferation of the fibrous tissue in response to chilling, toxic influence, trauma, or fatigue. Acutely tender fibrous bands and nodules frequently form in the muscles, tendons, ligaments, fasciae, periosteum, joint capsules, and nerve sheaths, and press on arterioles and nerve filaments, causing muscle spasm and secondary pressure effects." Fibrositis is no more one disease than is anaemia or arthritis. The primary type is of unknown etiology. The secondary type is part of the picture of some general infection—such as rheumatic fever, influenza, gonorrhoea, syphilis, atrophic arthritis—or a systemic disease,—such as hypertrophic arthritis, gout, plumbism, or alcoholism. The primary type may be classified according to the type of tissue, muscle, or group of muscles involved. The most frequent muscles involved are the sternocleidomastoid, the trapezius, the intercostal, the latissimus dorsi, the serratus anterior, the serratus posterior inferior and superior, the splenius capitis and cervicis, the sacrospinalis and semispinalis capitis, semispinalis dorsi and cervicis, and the small deep muscles of the back; the deltoid, and the muscles of the scapula,—such as the teres major, the rhomboidei, the supraspinatus and infraspinatus. Occasionally the muscles of the anterior abdomen (external and internal oblique, transversus abdominis, and rectus abdominis) are involved. The capsule and surrounding ligaments of various joints may be involved, at

which time the condition is spoken of as periarticular fibrositis. The bursae may be involved. The sheath of the sciatic nerve is often involved, and the condition is spoken of as perineural fibrositis. Tendons, fasciae, and aponeuroses may be involved. In the author's experience, the fascia lata, the inguinal ligament, and the palmar fascia of the hand have been frequently involved. Primary fibrositis may affect the subcutaneous fibro-areolar and adipose tissues.

Primary fibrositis is uncommon in young people. It usually manifests itself for the first time during the latter part of the fourth decade of life, and reaches its peak incidence in the fifth decade. Although most textbooks state that the disease occurs more frequently in males than in females, in the author's experience it has been equally divided between the sexes. The affected individual has the usual physical appearance of "good health". The disease may be acute or chronic. Acute attacks, not unlike that of gout, are the rule. However, these attacks usually last for a period of weeks, rather than days, which is characteristic of gout. Patients complain of severe pain and tenderness, which may be localized or generalized. The localized area may consist of a small tender nodule, the size of a pea, or may involve one muscle or group of muscles. These localized areas are not only tender, but are usually undurated and under spasm. The generalized condition is usually associated with generalized stiffness. Drafts and cold, damp weather definitely aggravate the condition or initiate an attack. Warm weather or the application of local heat brings relief. A slight degree of exercise usually limbers up these patients, and an excessive amount of exercise stiffens them again. Temporary deformities may occur during an acute attack. Thus an attack of fibrositis involving one of the sternocleidomastoid muscles may cause traction of the head to the affected side. Involvement of one group of the back muscles may cause a temporary lateral curvature of the spine. Fibrositis is usually characterized by the absence of an increased sedimentation rate, leukocytosis, or fever.

Stockman²⁴ has described the pathology of fibrositis at various stages: "Histologically they all consist of inflamed white fibrous tissue, the more recent ones being much less dense and containing more serofibrinous exudation than the older ones. The walls of the small blood vessels are much thickened, and the nerve filaments show interstitial inflammation". He showed one section of a small soft swelling, of about three weeks' duration, on the periosteum of the sternum. This section showed newly formed proliferating fibrous tissue, marked oedema, and many fibroblasts and blood vessels with many new capillaries. No leukocytic reaction was present. In another section, through a comparatively recent but older area of inflammation of the perimysium of the gluteus medius, new fibrous tissue was shown in a serofibrinous matrix. The fibroblasts were not numerous, and no leukocytes were present. All the coats of the small blood vessels showed very distinct thickening. Another section through an old, dense nodule from the heel showed closely packed fibrous tissue

with disappearance of the interspaces. Stockman also showed another section of chronic inflammation of the areolar tissue of the panniculus adiposus. Many fibroblasts were shown in the hypertrophied inflamed connective tissue. Interstitial neuritis was shown in the nerve twigs, and all walls of the blood vessels were thickened by increase in the connective tissue. Increased fat deposit was present in areas in which the



FIG. 1

Case 1. Photomicrograph ($\times 400$) showing polymorphonuclear infiltration, fibroblastic proliferation, and oedema.



FIG. 2-A

Case 2 Photomicrograph ($\times 400$) showing a small area of hyaline degeneration of muscle with loss of cross striations and disappearance of nuclei

inflammation occurred in patches. These patches were felt as small rounded fibrofatty tumors which were very painful on pressure, thus differentiating them from ordinary lipomata. He described the typical flexion deformities of the fingers occurring in Dupuytren's contracture as being due to the gradual contraction of this pathological fibrous tissue.

Abel and Siebert¹ described three stages in the pathology of primary



FIG 2-B

Case 2 Photomicrograph (X400) showing large area of hyaline degeneration of muscle with loss of cross striations, disappearance of nuclei and fibroblastic activity

fibrositis,—acute, subacute, and chronic stages. The acute and subacute stages show hemorrhages, hyperaemia, serofibinous exudate between the muscle bundles, newly formed fibroblasts, mild degenerative changes in muscle, swelling, loss of cross striation, and a few lymphocytes. The chronic stage shows fibrosis of muscle fascia and intramuscular septa, with separation of the muscle bundles, marked degeneration of the muscles

as evidenced by complete loss of cross striation, and hyalinization. There is also lobulation of perimyscular and subcutaneous fat.

CASE 1. A white female, aged fifty-seven, complained of attacks of generalized muscle stiffness and soreness of fourteen years' duration. These attacks lasted from one to thirty days. Her present attack consisted of soreness and stiffness of the back of the neck of several days' duration. A specimen for biopsy was taken from the trapezius



FIG. 3

CASE 3. Photomicrograph ($\times 400$) showing hyalinization with loss of cross striations, disappearance of nuclei, and fibroblastic activity.

muscle. The acute stage of fibrositis is represented by Figure 1. Section from this tissue showed polymorphonuclear infiltration, fibroblastic proliferation, and oedema. This patient had been diagnosed as a psychoneurotic by several physicians. Compare this with normal muscle (Fig. 6).

CASE 2. A white female, aged twenty-two, complained of severe pain in the entire back, of thirty-two months' duration. The onset was acute, after the patient had sus-

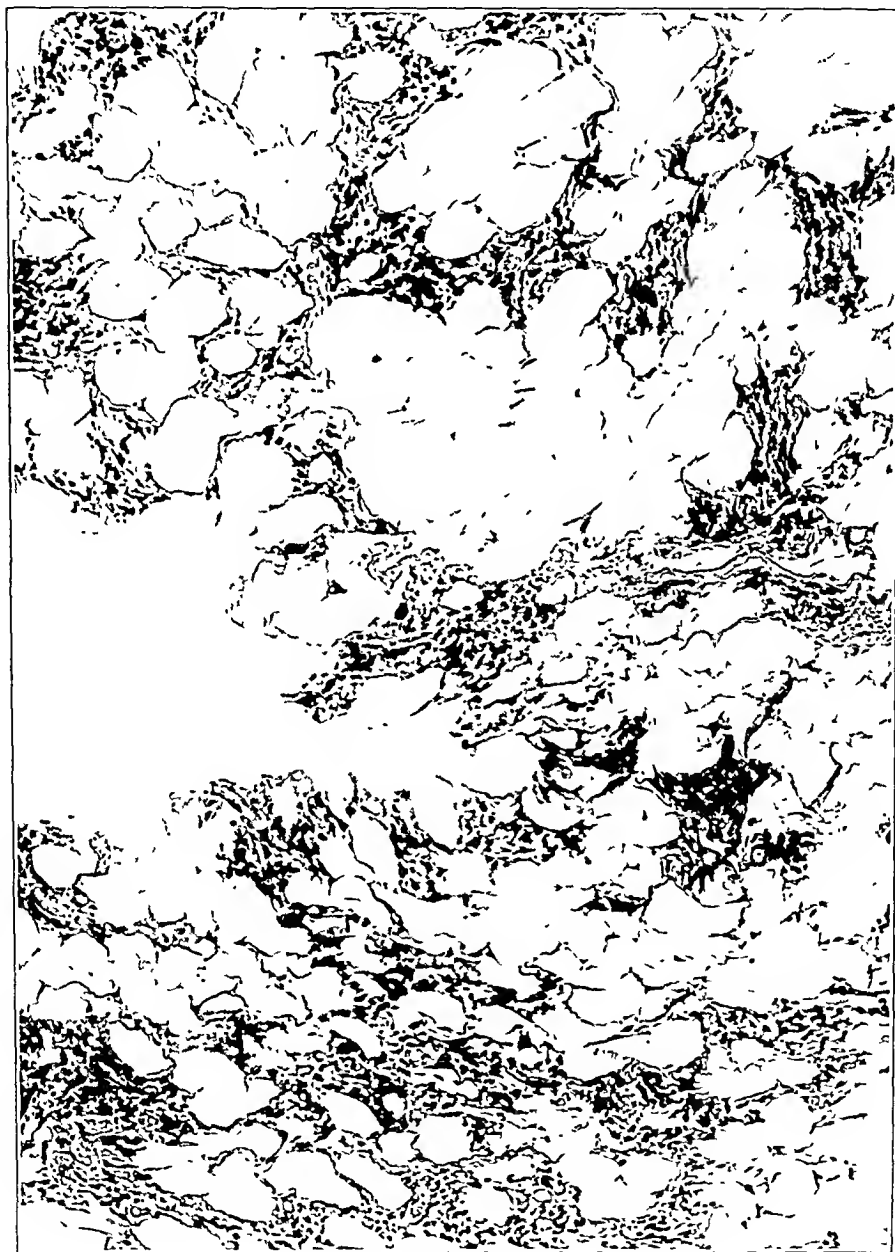


FIG. 4

Case 4. Photomicrograph ($\times 400$) of a nodule showing fibroblastic activity with increased local fat deposit.

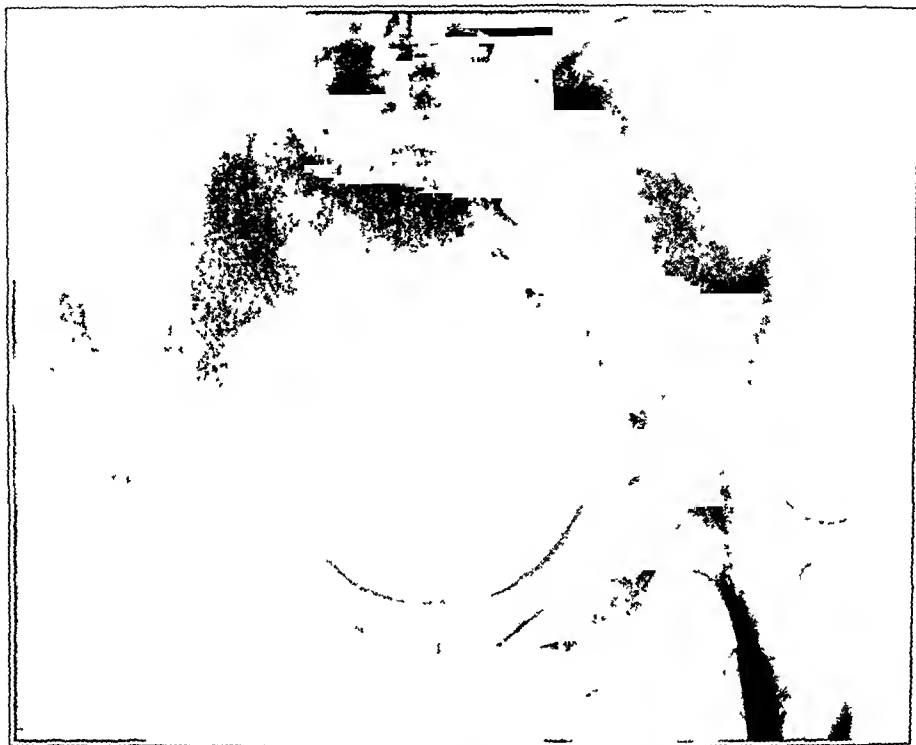


FIG. 5

Case 5 Roentgenogram of the pelvis showing calcification of the sacrotuberous ligament

tained a blow on the back. Marked tenderness was present over all the soft tissues of the back. Roentgenograms of the vertebrae and pelvis were negative. Sedimentation rate was 0.30 millimeters per hour (Wintrobe and Landsberg method); uric acid, 1.9 milligrams per 100 cubic centimeters; and serum phosphatase, 1.22 Bodansky units. Biopsy sections from the trapezius muscle showed one small area (Fig. 2-A) and one large area (Fig. 2-B) of hyaline degeneration of muscle, with loss of cross striations and disappearance of nuclei.

CASE 3. A white female, aged fifty-four, complained of attacks of lumbago over the previous two years. These attacks lasted from two to seven weeks. The present attack was in its second week. Examination revealed marked tenderness, induration, and spasm of the muscles of the lower back. Sedimentation rate was 0.42 millimeters per hour (Wintrobe and Landsberg method); uric acid, 1.5 milligrams per 100 cubic centimeters; and serum phosphatase, 3.3 Bodansky units. Roentgenograms of the pelvis and spine were negative. Biopsy sections from the latissimus dorsi showed hyalinization with loss of cross striations, disappearance of nuclei, and definite fibroblastic activity (Fig. 3).

CASE 4. A white female, aged fifty-five, complained of tender nodules on the right forearm and right leg of three week's duration. These nodules were very painful and tender. Biopsy of one of these nodules (Fig. 4) showed marked fibroblastic activity with increased local fat deposit. This picture is not unlike that described by Stockman²⁴ as occurring in panniculitis.

CASE 5. A white male, aged fifty-four, complained of backache of five months' duration. He stated that his backache was caused by lifting a heavy weight. He had pain also in the soft-tissue structures of the palms of his hands of three weeks' duration. Pain was produced by either flexion or extension at the hips. Sedimentation rate was

0.48 millimeters per hour (Wintrobe and Landsberg method). Roentgenograms of the pelvis (Fig. 5) showed calcification of the sacrotuberous ligament. This represents one of the end stages of fibrositis when the ligaments are affected.



FIG. 6

Photomicrograph ($\times 400$) of normal muscle showing normal cross striations and arrangement of nuclei. Compare this with the pathological changes in the above cases.

The pathology of primary fibrositis and that of nutritional muscular dystrophy occurring in young rats, as described by Pappenheimer, are strikingly similar. The early stages of nutritional muscular dystrophy show marked interstitial oedema, in part fibrinous. Marked inflammatory reaction with polymorphonuclears is present. The oedema soon disappears and the polymorphonuclears are replaced by mononuclear histiocytes. This is followed by calcification of the necrotic fibers. Nutritional muscular dystrophy was first described by Goettsch and Pappenheimer in rabbits and guinea pigs in 1931. Evans³ and his coworkers described degeneration of cross-striated musculature in rats whose diet was low in vitamin E. Knowlton and his coworkers described similar changes in skeletal muscle, resulting from diets deficient in vitamin E. Morgulis and Spencer in 1936, and Morgulis and his coworkers¹⁷ in 1938, reported that at least two factors, both present in whole wheat germ were required to cure nutritional muscular dystrophy in rats: a water-soluble factor present in defatted wheat germ, and a fat-soluble factor present in the unsaponifiable matter of wheat-germ oil. Mackenzie and his coworkers¹⁴ in 1940 were able to show that nutritional muscular dystrophy in the rabbit could be prevented and cured by alpha tocopherol in the absence of the water-soluble factor. They were able to refute the previous report of Morgulis and his coworkers^{16 17} that rabbits fed Pappenheimer's diet "13", deficient in vitamin E, required two factors for the structural integrity of their skeletal muscles. The water-soluble factor was not required. The antidystrophy requirement of the rabbit for prevention and cure of nutritional muscular dystrophy was found to be 0.6 to 1.0 milligrams per kilogram of body weight for alpha tocopherol. Another interesting observation of Mackenzie and McCollum was the establishment of simple criteria for the development and improvement of nutritional muscular dystrophy. It was found that a great increase in urinary creatine invariably attended the deficiency, and preceded gross symptoms by at least two weeks. A marked reduction in urinary creatine occurred within twenty-four to forty-eight hours after starting the administration of vitamin E.

Two previous communications^{21, 22} have called attention to the value of vitamin E in the treatment of primary fibrositis. Sydenstricker has called attention to the fact that the fat-soluble vitamins A, B, E, and K seem to be requisite for the maintenance and repair of certain specialized tissues. It has been the writer's contention that vitamin E is necessary for the prevention of the particular type of abnormal connective-tissue changes which occur in primary fibrositis and for the cure of this condition. John and Günther, Evans and his coworkers³, and Smith²⁰ have shown that more than a single chemical substance can function as vitamin E. The list of substances include hydroquinone itself, various ethers of durohydroquinone, chromanes, coumaranes, coumarines, coumarones, and alpha, beta, and gamma tocopherols. Over forty of these compounds show vitamin-E activity. This is nothing new in the field of biological

chemistry, as similar conditions exist in the case of vitamin D, vitamin K, and the estrogenic hormones.

This report concerns itself with various chemical combinations, physical forms, and routes of administration of the tocopherols in the treatment of primary fibrositis. Wheat-germ oil which contains alpha, beta, and gamma tocopherols was first employed by the writer in the treatment of primary fibrositis. It had several drawbacks: It was unpalatable; and it caused gastric disturbances and skin rashes. The assay of total tocopherols varies with different batches of wheat-germ oil. The tocopherol content of a molecular distillate of vegetable oils contains a fixed quantity of the tocopherols. Twenty cases of primary fibrositis were treated with this preparation. These patients were given 120 to 240 milligrams of total tocopherols daily. Marked improvement was noted in all cases. Forty more cases of primary fibrositis have been treated with this molecular distillate. These patients received 300 milligrams of total tocopherols the first week and then 150 milligrams of total tocopherols daily. Most of these patients manifested improvement in a period of one week of such treatment, and all except five were completely relieved of their fibrositic symptoms. These five patients were relieved from pain, but not completely from generalized stiffness.

Hickman and his coworkers have found that 95 per cent. of the tocopherols administered by mouth are excreted in the faeces of healthy individuals. Therefore, it was decided to try the parenteral route. Nine patients with primary fibrositis were given 334 milligrams of mixed tocopherols (alpha, beta, and gamma tocopherols) intramuscularly at weekly intervals. All had severe local reactions, consisting of swelling, pain, and increased local heat at the site of injection. Two had systemic reactions, consisting of fever, nausea, and vomiting. All these patients were observed for a period of three weeks, at which time this mode of administration of the molecular distillate had to be stopped. All noted marked relief in their fibrositic symptoms, and one patient showed complete disappearance of the fibrositic nodules (Fig. 4).

Each of twelve patients with primary fibrositis was given 200 milligrams of synthetic alpha tocopherol in corn oil intramuscularly at weekly intervals. These patients were observed over a period of two to four months. All noted marked relief in their fibrositic symptoms.

The inunction route was tried in four cases; 0.30 cubic centimeters of 40 per cent. solution of the molecular distillate containing alpha, beta, and gamma tocopherols was rubbed into the skin daily. These patients were observed over a period of two months. They objected to the bad odor of the drug; the results were poor.

Two salts of the tocopherols were tried in twenty-two cases of various muscle disorders. Twelve patients received 0.065 of a gram of alpha tocopherol succinate capsules by mouth three times daily. These patients were observed for a period of two to four months. Nine cases of primary fibrositis were completely relieved. No relief was obtained in one

case of secondary fibrositis and two cases of psychosomatic rheumatism. Ten cases of fibrositis received 0.065 of a gram of gamma tocopherol palmitate three times daily by mouth. These cases were observed over a period of two to four months. Complete relief was obtained in six cases of primary fibrositis. One patient with secondary fibrositis noted mild relief, but this patient noted marked relief with the oral molecular distillate. One patient with secondary fibrositis noted moderate relief. No relief was obtained in one patient with combined sclerosis complicating pernicious anaemia, and in one case of osteitis deformans. Sixty cases of primary fibrositis have been successfully treated by the oral administration of a molecular distillate of the tocopherols. Twenty-one cases of primary fibrositis were treated successfully by the intramuscular injection of alpha tocopherol or the molecular distillate. Alpha tocopherol succinate and gamma tocopherol palmitate were successfully used in the treatment of fifteen cases of primary fibrositis.

These clinical experiments indicate that either the oral or parenteral routes are equally efficacious. The striking similarity between the pathological changes of primary fibrositis and nutritional muscular dystrophy is no mere accident. This fact, plus the marked clinical improvement obtained in both conditions by giving the tocopherols, indicate that primary fibrositis is a metabolic disorder concerned with the deprivation of vitamin E. This paper concerns itself only with the antidystrophy biological factor of vitamin E. The recommended dosage at the present time is 300 milligrams of mixed tocopherols daily for the first week, and 150 milligrams by mouth daily for the next two weeks. A maintenance dose of 100 milligrams daily may be continued indefinitely. The calculated maintenance requirement of 1 milligram of the tocopherols per kilo of body weight should suffice for the average individual.

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SURGICAL TREATMENT OF PAINFUL HIPs OF ADULTS*

BY RALPH K. GHORMLEY, M.D., AND MARK B. COVENTRY, M.D.,
ROCHESTER, MINNESOTA

From the Section on Orthopaedic Surgery, The Mayo Clinic, Rochester

The relief of painful hips of adults seems to the authors to be one of the main problems before orthopaedic surgeons. Certainly, for those who examine many adult patients it is a common cause of symptoms, severe enough to cause many persons to seek relief. In many instances, it becomes a severely disabling condition. The authors have attempted to give relief to these patients by surgical measures.

A comparison of this report with the review of a group of cases reported by Henderson and Pollock, reveals an increase in the use of surgery in an effort to give these patients some relief. Henderson and Pollock reviewed the results of various surgical procedures carried out over a period of twelve years from January 1, 1926, to December 31, 1937, inclusive. In that period seventy-seven surgical operations were performed. It should be noted that their cases were of hypertrophic arthritis only, while the authors' included some cases of other types, although the underlying factor producing pain in all was probably hypertrophic change.

From 1938 to 1940, inclusive, seventy-one patients were treated by various surgical procedures. Seventy-six operations were carried out; four patients had operations on both hips, and one had two operations on the same hip.

The notable changes in the use of each procedure in this group, when compared with the work of Henderson and Pollock, are:

1. The abandonment of manipulation;
2. The decrease in the number of "drilling" operations;
3. The practical abandonment of cheilotomy;
4. The decrease in the number of reconstruction operations;
5. The increase in the use of acetabuloplasty;
6. The increase in the number of arthrodeses;
7. The increase in the use of arthroplasty.

These facts in themselves probably carry more weight than any long discussion of the merits or demerits of the various surgical procedures. The trends are obvious. The marked changes in the type of treatment selected reveal that these procedures in themselves are not yet stabilized, and that further modifications will be introduced in the methods of treatment for this condition.

* Read before the Annual Meeting of The American Academy of Orthopaedic Surgeons, Atlantic City, New Jersey, January 15, 1942.

TABLE I
CONDITION CAUSING PAINFUL HIPS IN SEVENTY-ONE CASES

Condition	No. of Cases
Old septic arthritis	9
Shallow acetabulum	7
Slipped epiphysis (ancient)	6
Legg-Perthes disease (ancient)	6
Congenital dislocation	5
Fractured femoral neck (ancient)	3
Traumatic dislocation (ancient)	3
Fractured acetabulum (ancient)	2
Spondylitis with secondary hypertrophic arthritis of the hip	2
Otto pelvis	1
Septic arthritis with pathological dislocation	1
Chondrodystrophy with coxa vara	1
Multiple loose bodies	1
Cause indefinite with or without history of trauma	24
Total	71

The authors do not mean to convey the idea that treatment in all such cases is surgical. It is their opinion that surgical treatment holds more promise of improvement or relief in properly selected cases than does conservative treatment. This opinion is based on the fact that from 1938 to 1940, inclusive, an additional 116 cases were encountered in which operation was not performed. Operative procedures were recommended in twenty-six of these cases, but were refused by the patients. For the most part, conservative treatment was recommended in the remainder. This treatment consisted in measures to reduce stress and strain on the hip,—such as crutches, reduction in weight, limitation of activity, local application of heat, and massage. In some cases, roentgenotherapy was used. From these measures, improvement in the amount of pain was obtained in less than one-third of the cases which were followed. Only about one-sixth of the patients had any improvement in the range of motion.

The construction of the hip joint is such that almost anatomical perfection is necessary in order to maintain the normal relationship between the surfaces of the acetabulum and the head of the femur. Any sort of irregularity in either of these surfaces will, in time, lead to degenerative changes which, in most cases, will result in the production of painful symptoms as well as limitation of motion. Whether the painful hip of an adult is called *malum coxae senilis* or *hypertrophic arthritis* or something else, it is the authors' opinion that some change in the nice relationship between the surfaces of the femur and the acetabulum leads to a painful hip of the type considered in this presentation, though it is often difficult to discover the remote inciting factor. In this series of seventy-one cases, impressions were that the defects given in Table I predisposed to the condition found at the time of treatment.

RESULTS OF OPERATION

As would be expected, the best results, from the standpoint of relief of pain, were obtained in the group of twenty-two cases in which arthrodeses were performed. This operation, successfully accomplished, is by far the most certain means of relieving pain. It cannot be used in all cases, however, because: (1) by no means all patients are willing to undergo arthrodesis with the resulting loss of motion of the hip; (2) patients who have involvement of both hips cannot, as a rule, be subjected to this procedure; and (3) patients who have arthritis of the lumbar portion of the spinal column cannot be subjected to the procedure.

Aged patients do not tolerate the long fixation necessary to produce satisfactory arthrodesis, and, of course, fixation is not so easily obtained. In this series, the three failures were in the cases of the three oldest patients, aged sixty-eight, fifty-nine, and fifty-six years, respectively. The average age of the patients in whom arthrodesis was carried out was forty-one years. For younger patients, who have disability in a single hip, and who are willing to adapt themselves to the inconveniences attendant upon a stiff hip, arthrodesis is most certain to offer relief from pain.

In 60 per cent. of the patients in whom acetabuloplasty was carried out, improvement was noted in the relief of pain and the amount of motion. Acetabuloplasty⁶ has less to offer than arthrodesis from the standpoint of the relief of pain. Although acetabuloplasty preserves motion, and although Smith-Petersen has stated that it has not given the results hoped for, the authors feel that it still has a place in the treatment of certain types of ailments of the hip, particularly among aged patients who cannot tolerate the more drastic procedure of arthroplasty⁷, or the long confinement in plaster casts attendant upon arthrodesis.

Arthroplasty, using vitallium cups, was performed in thirteen cases. This procedure was introduced in 1939 by Smith-Petersen. It has been used widely since that time by orthopaedic surgeons. The rationale of the procedure and the technique of the operation need not be repeated here. That many orthopaedic surgeons have hoped that it would offer a satisfactory method of treatment in many cases of painful hips in adults is obvious. Although the group of cases included here is small, it would seem from the figures presented that arthroplasty has a definite use in the treatment in these cases. In nine (69 per cent.) of a group of thirteen cases, less pain was present after the operation than before; and in eleven (85 per cent.) the range of motion was improved. Although these results seem to indicate that the procedure is worth while, it should be noted that in some cases the relief of pain has not been marked. The authors have been disappointed in that particular respect in several instances. Perhaps too much has been expected. It is true that the patients often were better satisfied than were the authors. Perhaps with the lapse of time, the results will prove to be even better than had been hoped for. With improvement in the operative technique, better results than are indicated here may be obtained. Whether the reaction to the interposition of a

foreign substance will lead to changes sufficiently severe to cause further exacerbation of symptoms, time alone will tell.

For the present, it is the authors' belief that cup arthroplasty should be carried out in cases of bilateral conditions of the hip, or in cases in which the lumbar portion of the spinal column is involved with some type of painful condition which contra-indicates the use of arthrodesis. They also believe that, in cases in which the patients will not agree to arthrodesis, cup arthroplasty offers enough promise of improvement to justify its use.

Use of the drilling operation, as suggested by Mackenzie, or "*forage*", as described by Graber-Duvernay has received considerable recognition, particularly in the European literature. The authors' experience with the procedure has been less encouraging than at first seemed likely. Improvement was noted in less than one-half of the cases after this operation. It undoubtedly is true that in some cases a marked degree of relief has followed the use of this operation; the authors are tempted to use the procedure in cases in which a minimal amount of surgical trauma is indicated. The operation certainly carries little risk. It might find a wider application if used in cases of hypertrophic arthritis of hips in the early stages, before extensive changes in the size and shape of the component parts of the hip have taken place. It is often difficult to convince patients who have lesions in that stage that an operation should be performed.

The shelf reconstruction operations are used in cases of congenital dislocation or subluxation of the hip, in which hypertrophic or traumatic arthritis is a superimposed condition. Other procedures have been used so seldom that little comment is necessary, except to note again the marked decrease in the number of times cheilotomy was performed, and the decrease in the number of reconstruction operations, indicating the unsatisfactory experience which has been had with the latter type of procedure. Osteotomy has not been used widely; although a certain amount of improvement may be obtained, it seems that this improvement must be temporary.

SUMMARY

The operation most certain to relieve pain in cases of painful hips is arthrodesis. Less certain relief of pain, but preservation of motion, will follow the use of cup arthroplasty. Acetabuloplasty offers a less certain means of treatment, but it has a definite place in certain types of cases, particularly among elderly patients. Drilling operations are indicated only in the earliest stages of hypertrophic arthritis of the hip joint.

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SEVERE OSTEOPOROSIS (OR OSTEOMALACIA) ASSOCIATED WITH LONG-CONTINUED LOW-GRADE STEATORRHOEA

BY GEORGE MIYAKAWA, M.D., AND GENEVIEVE STEARNS, PH.D.,
IOWA CITY, IOWA

From the Department of Orthopaedic Surgery and the Department of Pediatrics, The State University of Iowa Hospitals, Iowa City*

INTRODUCTION

Deficient absorption of calcium and phosphorus in infancy leads to rickets. Even in adults, when the bone growth has stopped, bone is not in a static condition. When calcium absorption is restricted in adults, a general rarefaction of the skeleton results, which is called osteomalacia.

In general, the cases in which this condition is evident fall into three main groups based on their etiology:

1. Pregnancy and insufficient calcium intake;
2. Starvation osteomalacia of war-torn people;
3. Idiopathic steatorrhea followed by osteomalacia.

Recently the authors have had occasion to observe far-advanced osteoporosis in a female, aged thirty-four. The clinical, laboratory, and roentgenographic findings were typical of osteomalacia, yet, according to the history, the diet had always been good. This patient was rather carefully studied and followed to clinical improvement, and it is shown to be one belonging in the third group.

The patient was first seen in the Orthopaedic Department in August, 1937, because of pain low in the back and deformity of the spine, which was rigid, with dorsolumbar kyphosis. Any attempted motion of the back caused pain. She was undernourished and asthenic. Relevant points in the history were as follows:

From the age of nineteen she had suffered from intermittent diarrhoea for about six years. She was seen in the Medical Department of this Hospital in 1925 for the complaint of unexplained diarrhoea and anaemia. At that time fat utilization was decreased to 72 per cent. of intake. In 1934 she developed aching pain in the metatarsophalangeal joints, both knees, and both shoulders. These symptoms were exaggerated during cold weather. She recalled no febrile reaction or swelling of the joints. During the latter part of 1936 she noticed a progressively increasing kyphosis, and the pain in the back increased also, particularly in the lumbar region. The pain in the extremities had somewhat decreased. At this time she was fitted with a body brace. The impression was ankylosing spondylitis.

She was seen again in June, 1939, at which time she was still wearing the brace, and complained of only occasional pain in the back. In June, 1940, the patient returned to the Hospital, complaining of shortness of breath, progressive kyphosis, pain in the left ulna, marked weakness, and loss of weight. She weighed eighty-six pounds, and was able to be up only a few hours a day because of extreme weakness. Menses had ceased in June, 1938. Her appetite was somewhat subnormal, but she had no diarrhoea or other gastro-intestinal complaints. The patient stated she had taken at least a quart of milk daily for the past two years. She had not taken vitamin D; otherwise her diet was apparently adequate. She was financially able to obtain a good diet.

* Service of Arthur Steindler, M.D.

Examination in June, 1940, revealed a cachectic female, thirty-four years of age, with marked kyphosis and resulting deformity of the sternum (Fig. 1-A). There were tender regions on both ulnae. The spine was rigid, and any attempt at motion caused pain.

Roentgenograms showed marked osteoporosis of the spine with compression of the vertebrae (Fig. 2-A). Both ulnae showed pseudofractures (Fig. 3-A) similar to those described by Looser in 1920. Roentgenograms also showed the typical deformity of the pelvis due to osteomalacia, and marked deformity of the sternum with osteoporosis (Fig. 4-A).

Gynecological examinations were reported as showing an infantile uterus.

The patient was admitted for study. The findings are reported in Table I. The blood picture was typical of severe osteomalacia. The patient was given a diet containing 1200 cubic centimeters (one and one-quarter quarts) of milk daily, and having a fat content of approximately seventy grams. No vitamin-D therapy was given, as it was wished to simulate the patient's previous diet. Under this regimen the patient was unable to retain calcium, but did retain phosphorus and nitrogen. The urinary excretion of calcium was very low—about one-tenth of the customary amount—and the faecal calcium equalled the intake. (These values indicate faulty absorption of calcium.)

Examination of a faecal sample showed the fat content to be about 20 per cent. of the wet weight,—double the normal value. Gastric analysis showed a normal level of both free and combined acids.

The patient's condition could be considered as due to vitamin-D deficiency, or to a chronic deficiency in absorption of fat, which is known to be associated with a lowered absorption of calcium from the intestine, or, more probably, to a combination of both factors. From the history, a continuous low-grade deficiency of absorption of fat seemed probable, and could account for the defective absorption of calcium. With increasing invalidism the patient would be indoors more and receive less ultra-violet irradiation; this, in turn, would decrease the absorption of calcium still further. A vicious cycle seemed inevitable under these conditions.

A study of the patient's dark adaptation showed her vitamin-A status to be normal. The decrease in fat absorption, then, was not sufficient to lead to a deficiency of vitamin A, which is carried in the dietary fat. Presumably, then, if the vitamin-D intake were ample, a sufficient amount of this vitamin could be absorbed.

Because of the severity of the patient's condition, and the fact



FIG. 1-A

FIG. 1-B

Fig. 1-A: June 13, 1940. Patient at the beginning of treatment weighed eighty-six pounds.

Fig. 1-B: October 25, 1940. After four months of treatment patient weighed 100 pounds.

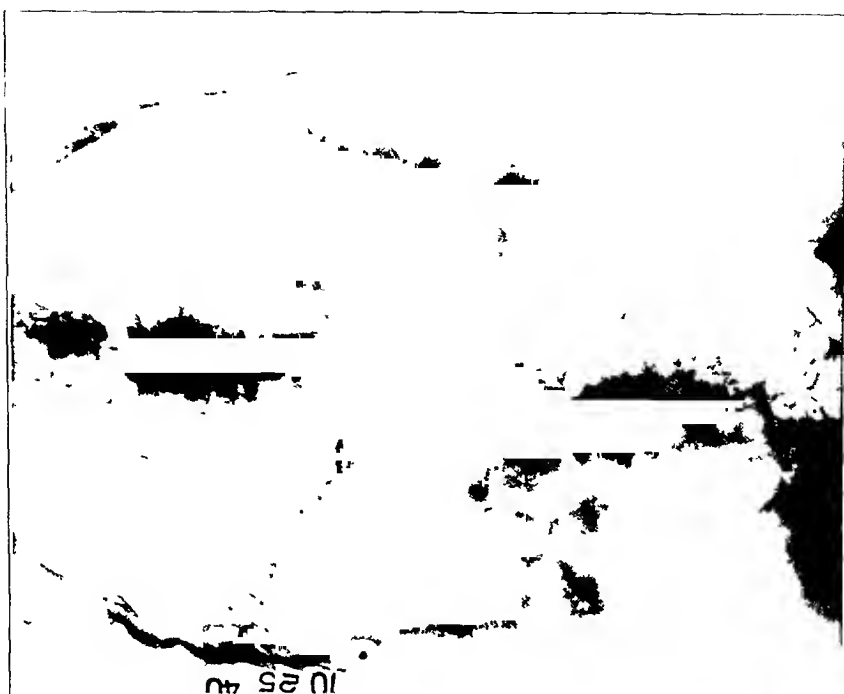


FIG. 2-B

October 25, 1940. Anteroposterior view of the spine shows calcium deposition in the thoracolumbar vertebrae after treatment.



FIG. 2-A

June 13, 1910. Anteroposterior view of the spine shows marked osteoporosis of the thoracolumbar vertebrae.

that she could not remain under close supervision, it was decided to make the therapy ample, both in the matter of vitamin-D intake and in aiding fat absorption. The patient preferred to drink whole milk, rather than skimmed milk. She was, therefore, sent home under the following regimen: one and one-half quarts of milk daily; two teaspoonfuls of cod-liver oil (1200 U.S.P. units of vitamin D) daily; bile salts, five grains, three times daily; pancreatin, five grains, three times daily; and calcium lactate, ten grains, three times daily. The prescribed diet was low in fat content, but nutritionally was ample. The patient was ordered to lie on a boarded bed. No endocrine therapy was instituted.

The patient was seen in September, 1940, and stated that she was much improved and had gained thirteen pounds. The regimen was continued.

The patient returned to the Hospital on October 25, 1940, three and one-half months after the beginning of her regimen. She weighed 100 pounds, a gain of fourteen pounds. The ulnae were no longer tender to palpation. The respiratory symptoms had disappeared, and the patient wished to be allowed up. According to the patient and her mother, the regimen had been followed strictly. She had menstruated for the first time

in about two years.

Roentgenograms showed the findings as seen in Figures 2-B, 3-B, and 4-B. She was admitted to the Hospital and kept on the same regimen as before. The metabolic studies were repeated (Table I).

The blood findings were those of healing osteomalacia. The phosphatase value, though less than half the original value, was still sufficiently above normal to indicate that healing was not yet complete, even though the roentgenographic examination showed marked deposition of mineral in all bones. The urinary excretion of calcium had not increased, but the faecal excretion had decreased markedly, permitting a calcium retention of half a gram daily. The phosphorus retention had decreased, so that the ratio of calcium to phosphorus retained could now be considered optimal for mineralization of bone. It was assumed that the primary need had been for calcium rather than for phosphorus.

The pancreatin, bile-salt, and calcium-lactate therapies were discontinued, and the patient's retention of minerals studied with vitamin-D therapy only. The success of this study was somewhat marred by the incidence of a slight upper respiratory infection, which may have

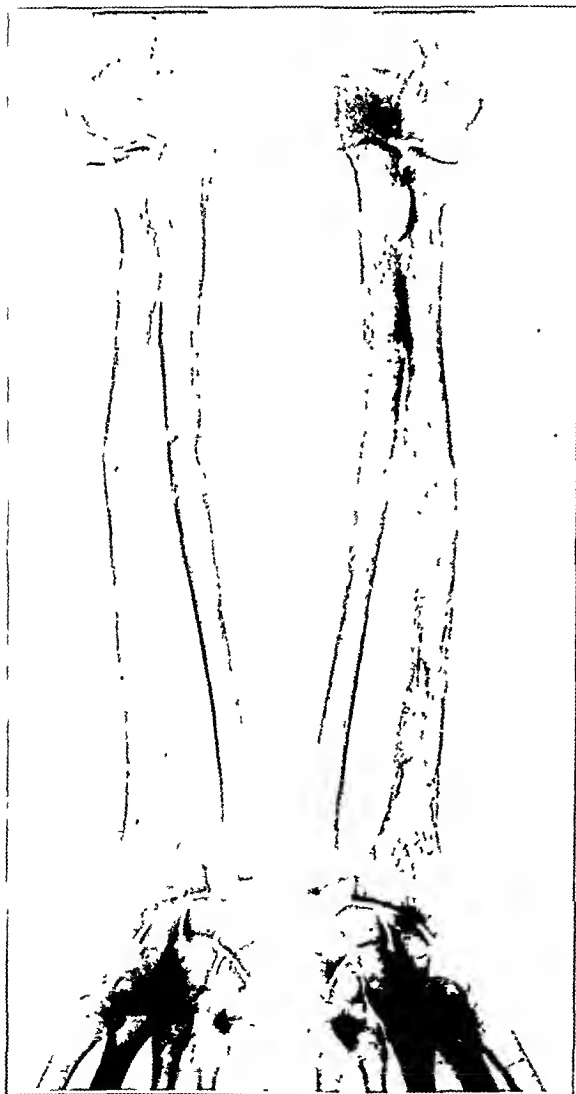


FIG. 3-A

June 13, 1940. Pseudofractures of the ulnae.

been responsible for the diarrhoea which occurred for two days soon after the change in regimen. Notwithstanding the slight illness preceding the period of study, the retention of both calcium and phosphorus was excellent. The excretion of fat was notably increased, however; analysis of a single faecal specimen showed 41 per cent. of the wet weight of the stool due to fat, in contrast to 12 per cent. found during the previous period, with the same dietary intake.

Because of the sharp decrease in fat utilization two weeks after bile-salt and pancreatin therapies were discontinued, the patient was advised to return to the regimen with which she did so well. A Telson type of cast was applied to attempt to straighten the dorsum rotundum which was still present.

In April, 1941, the patient returned to the Clinic, stating she felt fine and had remained on her regimen. Her weight was 110 pounds,—a total gain of twenty-four pounds in eleven months. The blood findings indicated healing osteomalacia. The patient has menstruated regularly since October, 1940. She was advised to remain on the dietary regimen, but to return to work.

The patient returned for a check-up in July, 1941. She had been working at sorting fruits in a cannery and had maintained her weight. Blood phosphatase was thirteen and six-tenths Jenner-Kay units.

In January, 1942, the patient was again examined and was found to be in good condition.

DISCUSSION

A severe and rapidly progressing osteomalacia developed in this patient apparently within the course of four or five years. The history suggests that impairment of fat absorption, occasional or constant, preceded the onset of osteomalacia by about ten years. The impairment had not been sufficiently marked to cause diarrhoea for the previous eight or nine years; yet during this period the effects of the mineral deficiency became apparent and progressed rapidly. It is well known

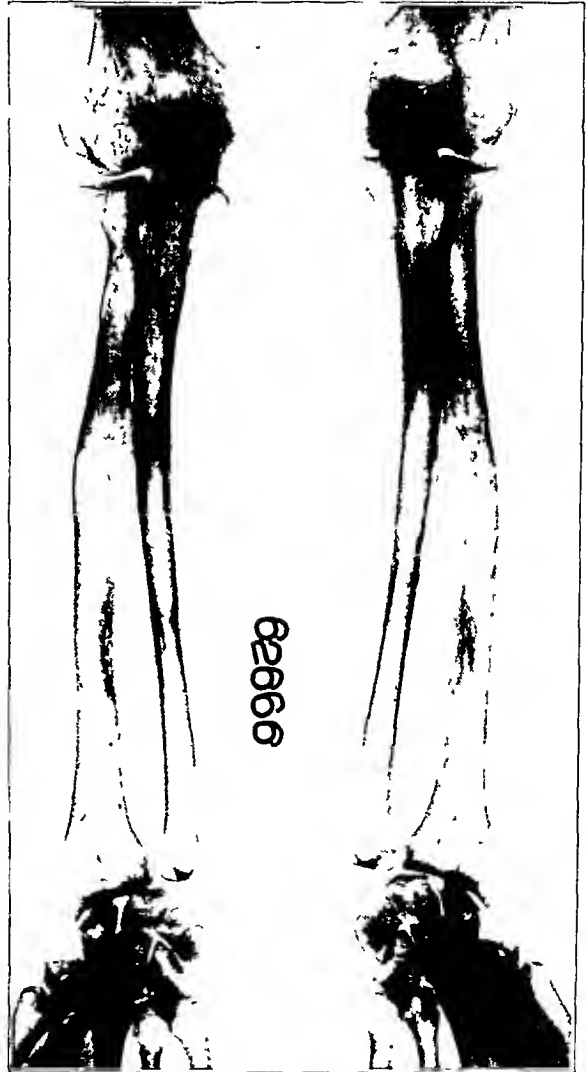


FIG. 3-B
October 25, 1940. Healed pseudofractures of the ulnae.

TABLE I
METABOLIC STUDY OF A WOMAN, THIRTY-FOUR YEARS OLD, WITH SEVERE OSTEOMALACIA

Date and Therapy	Essential Substances in Diet	Daily Intake (Grams)	Daily Excretion			Daily Retention (Grams)	Serum		
			Urine (Grams)	Faeces (Grams)	Total (Grams)		Calcium (Milligrams per 100 Cubic Centimeters)	Phosphorus (Milligrams per 100 Cubic Centimeters)	Phosphatase* U/100
July 1 to 6, 1940 No therapy	Calcium	1 366	0 016	1 360	1 376	— 010	8 8	2 5	36 3
	Phosphorus	1 546	1 041	0 236	1 277	+ 269			
	Nitrogen	12 58	8 86	1 82	10 68	1 90			
	Fat			19 5%**					
November 1 to 6, 1940 Vitamin D Bile salts Pancreatin Calcium lactate	Calcium	1 619	0 011	1 082	1 093	+ 526	10 1	4 0	17 6
	Phosphorus	1 574	1 250	0 194	1 444	+ 130			
	Nitrogen	13 04	9 83	1 46	11 29	1 75			
	Fat			12 33%**					
November 16 to 21, 1940 Vitamin D	Calcium	1 616	0 009	1 203	1 212	+ 404			
	Phosphorus	1 743	1 136	0 232	1 368	+ 375			
	Nitrogen	12 67	8 32	2 74	11 06	1 61			
	Fat			41 0%**					
July 23, 1941									13 6

* Jenner-Kay units of phosphatase, — normal value 6 to 10 units.

** Percentage of wet weight of faeces.

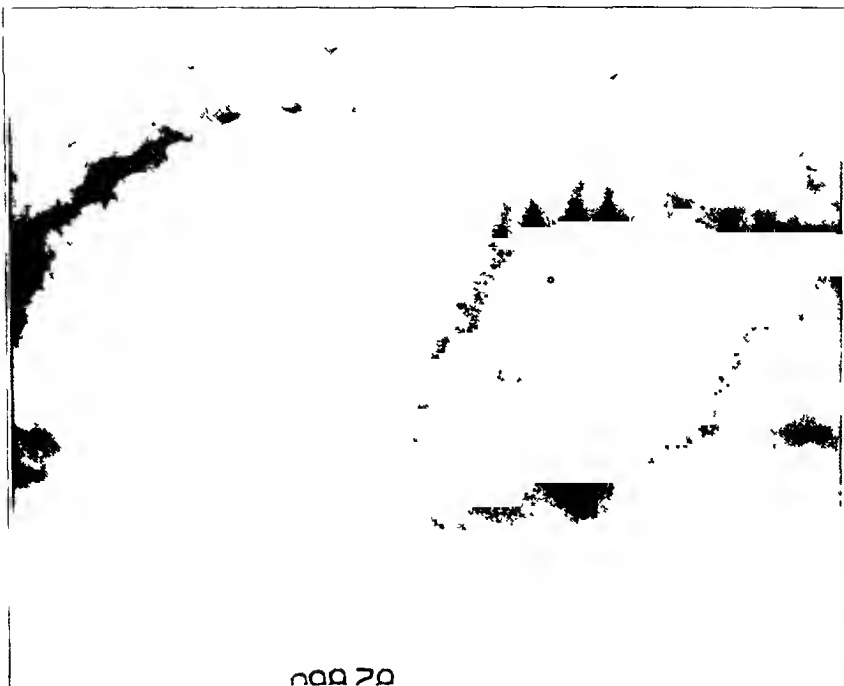


Fig. 4-B



Fig. 4-A

Fig. 4-A. June 21, 1940. Lateral view of the spine shows far-advanced osteoporosis.
 Fig. 4-B. October 27, 1940. Lateral roentgenogram of the spine, following eight months of treatment, shows the deposition of calcium to be most marked along the intervertebral spaces.

that chronic steatorrhoea (celiac disease, sprue, Gee's disease) is associated with impaired absorption of bone minerals, and leads to the development of rickets or osteomalacia.

A steatorrhoea so slight as to be symptomless most of the time is not usually associated with the development of so severe an osteomalacia. It is to be regretted that a more complete determination of the relative rôles played by vitamin-D deficiency and by the steatorrhoea could not have been made in this patient. With the aid of vitamin D, she was able to maintain, at least temporarily, the ability to absorb calcium and phosphorus, notwithstanding a high fat excretion. How long she could have continued to do so was not determined. The increased excretion of fat must necessarily remove from the gastro-intestinal tract a considerable quantity of the fat-soluble vitamins, necessitating a larger vitamin-D intake than would be needed by the normal adult. It seems that adequate vitamin-D therapy should be given to all patients with a history of chronic diarrhoea to prevent the development of osteomalacia.

This case of osteomalacia is of further interest because the accompanying amenorrhoea might have been considered evidence of endocrine imbalance. The temptation to use endocrine therapy is always great because of the occasional dramatic changes brought about with its use. With the history obtained from this patient, the presence of sufficient nutritional factors was obvious. Regulation of the patient's nutrition proved the endocrine imbalance to be dependent upon the faulty nutrition rather than the reverse.



FIG. 5

April 24, 1941. Malacic deformity of the pelvis.

SUMMARY

A far-advanced case of osteomalacia appears to have developed in the absence of marked dietary indiscretions. The milk intake had been ample for at least two years, but no additional vitamin D had been ingested.

The patient showed a persistent elevation of faecal fat. The history indicated that some degree of steatorrhoea had been present for more than ten years. It seems probable that this mild degree of steatorrhoea over so long a period was a major factor in the development of the osteomalacia. Retention of bone minerals was ample when cod-liver oil, bile-salt, and pancreatin therapies were instituted in conjunction with the ingestion of a diet rich in calcium and phosphorus, and low in fat content.

The authors have encountered one other patient whose spine shows far-advanced osteoporosis and whose stools show elevated faecal fat. It is too early to tell what results dietary and medical management will produce in this case. But it is possible that in a certain number of cases of so-called idiopathic osteoporosis, the primary fault lies in the patient's inability to digest fat.

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SYNOVIOMA OF THE KNEE JOINT

A CASE REPORT

BY G. E. HAGGART, M.D., BOSTON, MASSACHUSETTS

*From the Department of Bone and Joint Surgery,
The Lahey Clinic, Boston*

Tumors of the articular synovial membrane, most commonly termed synoviomata, are now well recognized, although encountered comparatively infrequently. The prognosis is, as a rule, not favorable, because the tumor tends to recur locally and, in addition, may metastasize. Histological examination of the tumors which recur following operation demonstrates an increasingly malignant type of cell.

Because of the unfavorable prognosis in this relatively rare tumor, the following case is reported, in which the mass was excised, and there has not been a recurrence over a period of eight and a half years.

The patient, a grocery clerk, aged thirty-eight, was admitted to the Clinic May 9, 1933, because of pain and disability of the left knee, with particular reference to a swelling which had appeared on the side of the joint.

The patient stated that a swelling in the same region had been operated upon elsewhere fifteen years previously. His family was then informed that this was a bony growth. He had had no trouble with the knee following the operation until about eight years before he came under the author's observation, when a slight swelling appeared on the outer side of the left knee, and then disappeared after a month. There was no known cause, and the swelling recurred at intervals. This intermittent appearance of the swelling persisted until seven months previous to admission, when, while lifting a heavy box, his foot slipped, and almost immediately the swelling reappeared, this time much larger



FIG. 1

Preoperative photograph of left knee, showing cystic swelling on the lateral aspect of the knee region.

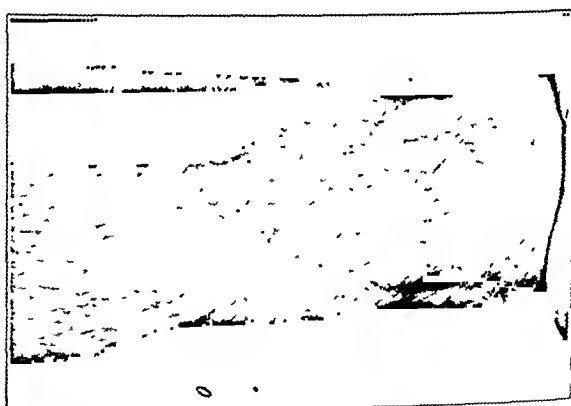


FIG. 2-A

Photographs taken eight and one-half years post-operatively, illustrate the normal range of motion in the knee joint. (See also Fig. 2-B.)

than it had ever been before. With this swollen joint he experienced severe pain in the knee, which persisted, together with a sense of numbness on the outer side of the lower leg, extending from the knee to the ankle region. While in previous attacks local application of heat had always caused the swelling to become less pronounced, after the injury described, heat had no effect upon the size of the swelling. There was no limitation of knee motion, and the joint was stable. The appearance of the knee on admission is shown in Figure 1.



FIG. 2-B

The findings on general medical examination were not remarkable. The local examination of the knee was negative except for the swelling, as illustrated. This was firmly attached to the underlying deep fascia, and apparently in part to the subcutaneous tissue, although the skin was movable over the tumor. The swelling was definitely tense and cystic to palpation, and moderately tender. Roentgenograms of both knee joints were negative. Routine urine and blood examinations, including a Wassermann test, were negative. Excision of the mass was advised, and the man was admitted to the New England Deaconess Hospital on June 12, 1933, and operated upon two days later. The preoperative diagnosis was cystic swelling of the lateral region of the left knee, type to be determined.

The mass was exposed by an elliptical incision, leaving intact the



FIG. 3

Photograph of specimen removed (actual size). The skin overlying the tumor was excised *in situ* while the tail-like projection, mentioned in the text, is coiled up and lying on the surface of the mass to the left.

skin directly over the tumor. The cystic mass was found to be firmly adherent to the underlying deep fascia, to the knee-joint capsule, and to the periosteum over the head of



FIG. 4-A

Low-power and high-power (Fig. 4-B) photomicrographs. The tumor tissue is somewhat lobulated and is infiltrating the adjacent connective tissue irregularly. The cells are spindle-shaped, without intercellular substance. In some places there is a tendency to the formation of whorls. There are frequent spaces, with some orientation of the tumor cells to line them. Mitotic figures are present, but rare. Diagnosis: synovioma of the knee, recurrence probable.

the fibula, as well as to the common peroneal nerve, and was separated from these structures with some difficulty. It was then found that the mass tapered off into a tail-like projection which entered the knee joint posterior to the lateral collateral ligament. The joint was opened, and the portion of the capsule immediately adjacent to this tail-like projection was excised. The projection was intimately adherent to the external semilunar cartilage, and seemed to arise from the synovial membrane in this area, which exhibited a local fold or thickening that extended around posteriorly to the midline. This



FIG. 4-B

synovial membrane was likewise removed, as was also the external semilunar cartilage.

In order to close the defect created by the excision of the skin overlying the mass, it was necessary to make an additional "releasing" incision, thus permitting primary suture of the operative wound. The secondary wound was covered with a Thiersch skin graft.

The immediate postoperative period was relatively stormy, as the patient reacted severely to the accumulation of serum in the knee, and, therefore, skeletal traction was applied to the os calcis. The joint was aspirated and local, hot, wet dressings were applied. Culture of the joint fluid was negative. Under this regimen, all reaction subsided, and the wounds healed without complication.

On the twelfth day after operation, the patient started on active exercises, and was discharged from the hospital ten days later, walking with crutches to protect the quadriceps muscle. He returned to his usual occupation six weeks after operation, and has continued in that work ever since. Figures 2-A and 2-B are photographs which illustrate the normal range of motion and absence of swelling at the present time. Figure 3 is a photograph of the excised mass, and Figures 4-A and 4-B are low-power and high-power photomicrographs of the tumor. Dr. Shields Warren made a diagnosis of synovioma, and stated that recurrence was probable.

Since operation the patient has been examined at least once a year and sometimes more often, as he occasionally has come to the Clinic because of other complaints that have had no relation to his knee, notably gastro-intestinal disturbances. His condition at the present time is excellent. He has no symptoms whatsoever in his knee, and the joint function is normal. He considers his general health very satisfactory. The last examination was made on October 4, 1941, eight years and five months following operation. There was no evidence of recurrence of the tumor. Roentgenograms of his knee and lungs were negative and examination of the extremity was negative.

SUMMARY

The tumor mass originally appeared as a cystic swelling on the lateral aspect of the knee, and at operation was found to communicate with the knee joint and to arise from the synovial membrane in the posterior compartment of the knee. The tumor was firmly adherent to the external semilunar cartilage, which, together with the tumor mass, was removed. Eight years and five months after operation there was no evidence of recurrence, and the patient had normal function of the knee joint.

TWO UNUSUAL TRAUMATIC DISLOCATIONS OF THE HIP

BY ROBERT V. FUNSTEN, M.D., CHARLES J. FRANKEL, M.D., AND LEONARD HARRIS, M.D., CHARLOTTESVILLE, VIRGINIA

From the Department of Orthopaedic Surgery, University of Virginia Hospital, Charlottesville, Virginia

The following cases are probably the most unusual that the authors have seen in a number of years.

CASE 1. J. L. R., a white man, forty-nine years old, was in an automobile accident on November 17, 1940, and sustained a posterior dislocation of the right hip (Fig. 1-A).

The roentgenogram at that time showed a dislocation of the right hip, with detachment of a large fragment of the superior lip of the acetabulum, measuring four by two centimeters. The head of the femur was displaced markedly upward.

Under gas and oxygen anaesthesia, the dislocation was reduced by the Allis method, and the patient was put up in Russell traction with ten pounds of weight. He was discharged from the Hospital on December 8, 1940, walking on crutches and not bearing any weight on the right leg.

On January 7, 1941, the roentgenogram showed the detached upper margin of the acetabulum to be in such a position as to form a projecting shelf over the head of the femur, 3 centimeters in length by one and one-half centimeters in diameter (Fig. 1-B).

On February 4, 1941, full weight-bearing was allowed.

The shelf, as formed by the fractured fragment, is the only one that the authors have ever seen. The hip is stable and painless, and allows an excellent range of motion.

The second case is one of the few traumatic, anterior dislocations of the hip seen here.

CASE 2. T. M., a colored man, twenty-four years old, was first seen in this Hospital on March 9, 1941, with the complaint that he had been struck on the left hip with an axe, approximately twenty hours before admission. He was found to have a large gaping wound over the left hip, through which protruded the head of the femur.

The roentgenogram showed the head of the left femur to be riding upward out of the acetabulum (Fig. 2-A). The head was displaced laterally and anteriorly, and the upper portion of the head was at a level two and a half centimeters above the superior border of the acetabulum. The greater trochanter was detached, forming a fragment five centimeters in its greatest diameter, and lying somewhat medial and above the head proper. There was a line running through the head extending three centimeters medial to the outer border, which was apparently due to an incised wound. There were several small bone chips lying in the soft parts.

The axe had apparently passed through the base of the greater trochanter and the superior margin of the neck into the head of the femur.

In the operating room a thorough débridement of the wound was carried out. Several loose bone fragments were removed from the wound, the dislocation was reduced, and the detached fragment of the greater trochanter was wired into place. Seven and one-half grams of sterile sulfanilamide powder was sprinkled throughout the wound. The capsule was closed, and several soft-rubber drains were inserted down to the capsule. The wound was then closed tight around the drains, and a hip spica was applied. The patient was given a prophylactic dose of tetanus and gas antitoxin, and was started on sulfanilamide (ninety grains per day) by mouth. He was also given prophylactic roentgen therapy to the left-hip region. The postoperative course was uneventful. On



FIG. 1-A

Case 1. Posterior traumatic dislocation of the hip, showing fragment from the superior rim of the acetabulum.



FIG. 1-B

Case 1. Showing dislocation reduced, with fractured fragment now firmly united and forming a perfect shelf over the head of the femur.



Fig. 2-B

Case 2 Dislocation reduced. A loss of bone from the superior edge of the neck and head of the femur is apparent.



Fig. 2-A

Case 2. Traumatic anterior dislocation of the hip, showing detached greater trochanter.

March 12, 1941, a window was cut in the cast, and the drains were removed. There was no evidence of infection, and the wound was healing satisfactorily. The cast was then reinforced, and the patient was discharged on March 30, 1941. On May 15, 1941, the cast was bivalved and motion was started at the hip.

On July 24, 1941, the roentgenograms showed the severed greater trochanter to be firmly united (Fig. 2-B). Full weight-bearing was started at that time.

On September 11, 1941, the patient was walking without a limp, the hip was painless, and there was a good range of motion (Fig. 2-C), except in flexion which was limited to about fifty degrees. The patient was allowed to return to work at that time.

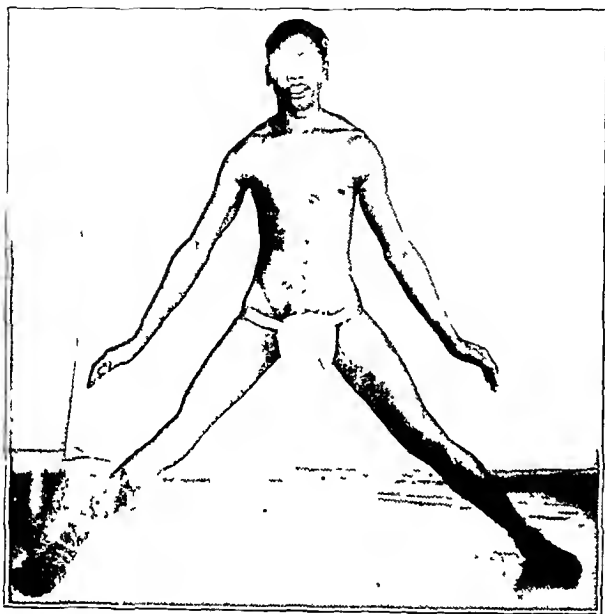


FIG. 2-C

Case 2 Demonstrating range of abduction.

This second case is of special interest because the question of closure of the wound twenty hours after the injury had to be considered.

The wound was closed in spite of the fact that twenty hours had elapsed since the injury was received, because it was felt to be relatively clean. By using sulfanilamide powder locally and orally, and by using drains for forty-eight hours, it was believed that the chances for obtaining a good functioning hip joint would be better than if the wound were left open.

It was felt that in Case 2 the primary closure was certainly responsible for part of the good functional result to date. In general the authors do not advocate closure of wounds that are of over eight hours' duration, but the surgeon must utilize his personal judgment as against fixed principles.

In these cases it is of course too early to determine an end result in view of the possibility of development of aseptic necrosis of all or part of the head.¹ These patients will of course be followed, and the evaluation of the end results will not be determined before two years after the time of the injury.

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ROENTGENOGRAPHIC STUDY OF ACUTE OSTEOMYELITIS OF THE FIBULA TREATED CONSERVATIVELY

BY RAPHAEL R. GOLDENBERG, M.D., F.A.C.S., PATERSON, NEW JERSEY

*From the Nathan and Miriam Barnert Memorial Hospital, Paterson **

This case is presented because it gives a graphic demonstration of the destructive and reparative processes as depicted on the roentgenograms in a surgically undisturbed instance of acute osteomyelitis.

A. I., male, eleven years old, was admitted to the Nathan and Miriam Barnert Memorial Hospital on July 19, 1937, complaining of a feverish feeling and of pain in the left leg of five days' duration. On the day following the onset, he experienced a chill of five minutes' duration. The temperature rose to 104 degrees. The pain thereafter became so intense that the child was unable to move the left lower extremity. There was no history of preceding trauma or relevant illnesses.

On admission to the Hospital, the left lower extremity was held in abduction and external rotation with slight flexion at the hip and knee. There were local heat, redness, swelling over the antero-medial aspect of the proximal third of the left leg, and exquisite tenderness over the head of the fibula. On gentle manipulation the knee could be moved through a range of 80 degrees. The left calf was enlarged seven-eighths of an inch. The general examination was negative, except for several small abrasions over the legs and feet. The leukocyte count was 25,100, with 89 per cent. polymorphonuclears, many of which were young forms. The first blood culture revealed eight colonies of staphylococcus aureus, but the later cultures remained sterile. Urinalysis was negative save for a faint trace of albumen. Roentgenographic examination (Fig. 1) on July 20, 1937, the sixth day of the illness, was thought to be negative, but in retrospect a small oval area of rarefaction can be visualized immediately below the proximal epiphyseal line.



FIG. 1

July 20, 1937. Small oval area of rarefaction immediately below the epiphyseal line.

*Surgical Service of Dr. William Spickers.



Fig. 2
July 24, 1937. Area of rarefaction in the metaphysis with break in the anterior aspect of the cortex.

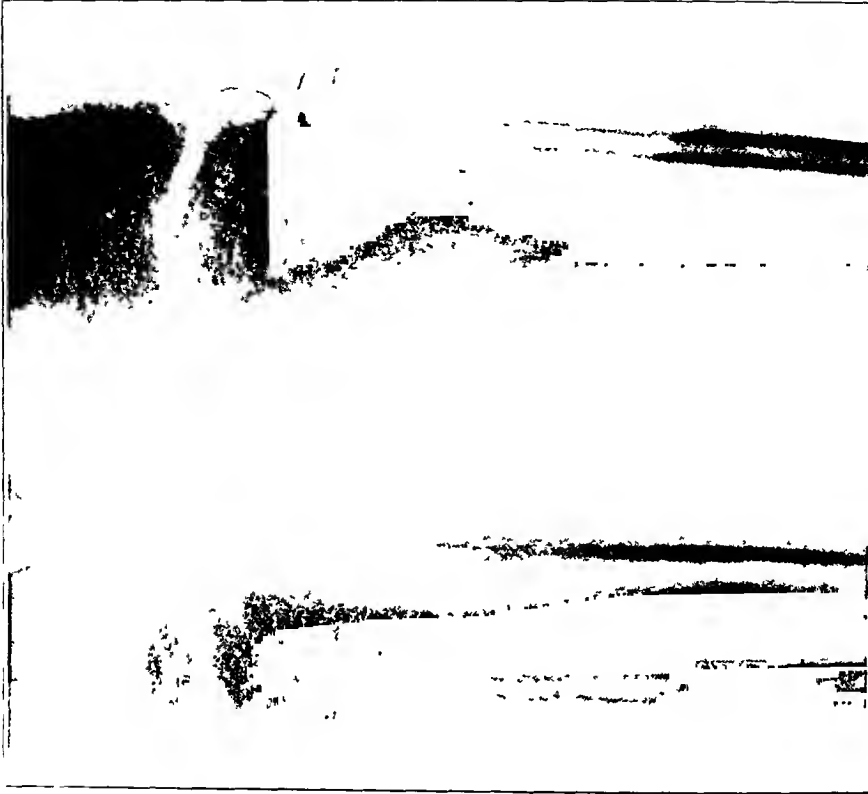


Fig. 3
August 13, 1937. Extensive destruction of the proximal four inches of the fibula.



Fig. 5

April 1, 1938. Beginning reformation of fibula and medullary canal.

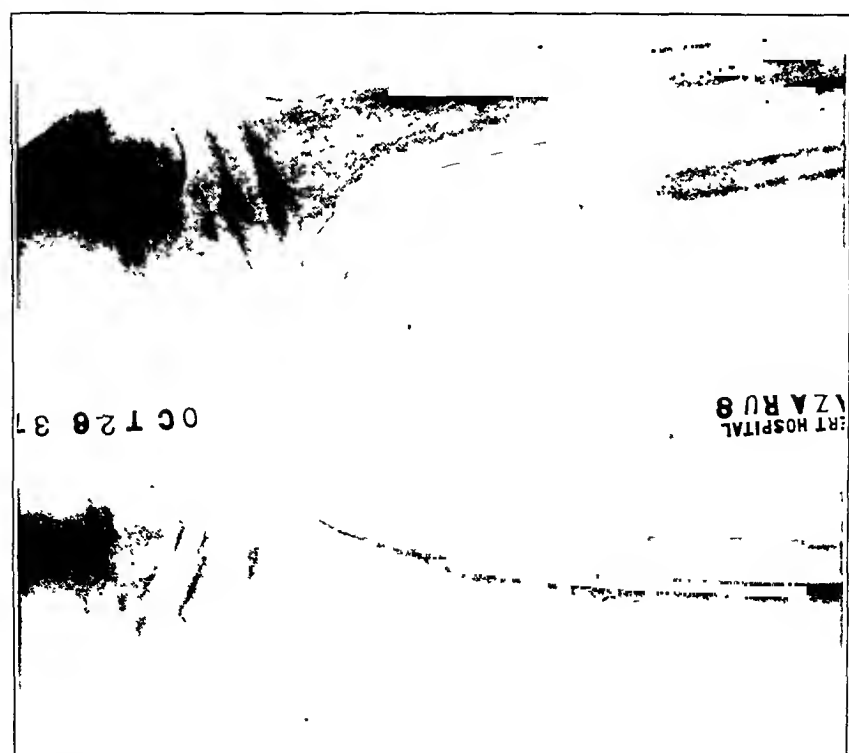


Fig. 4

October 26, 1937. Almost complete destruction of the proximal four inches of the fibula, with bulging of the partially ossified periosteum.

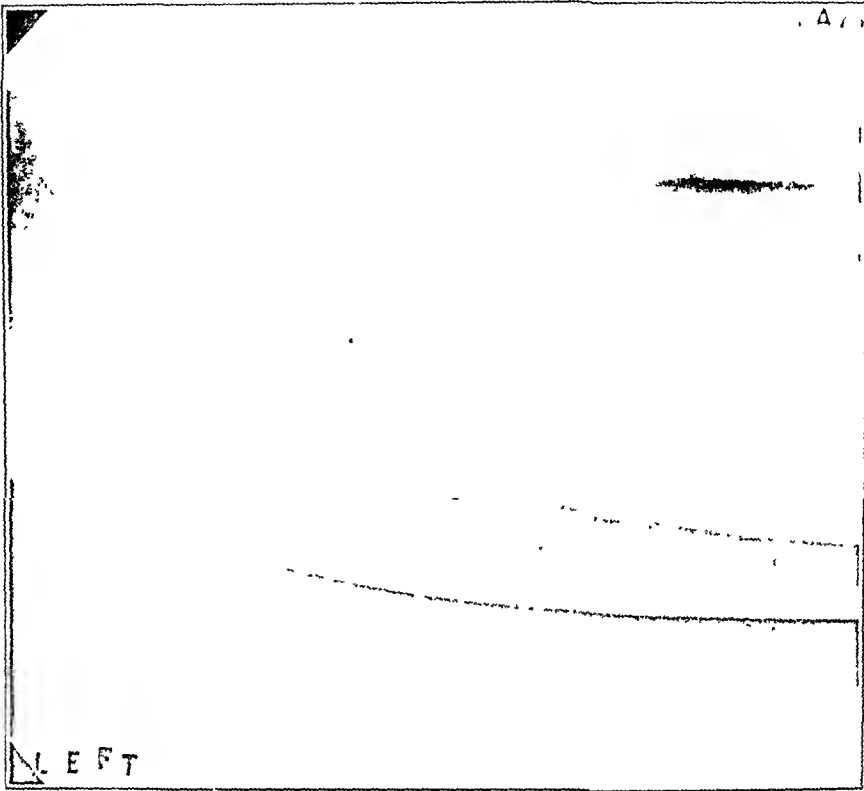


FIG. 7

September 14, 1940. Reformation of the fibula is almost complete. There are no areas of rarefaction suggestive of active disease.

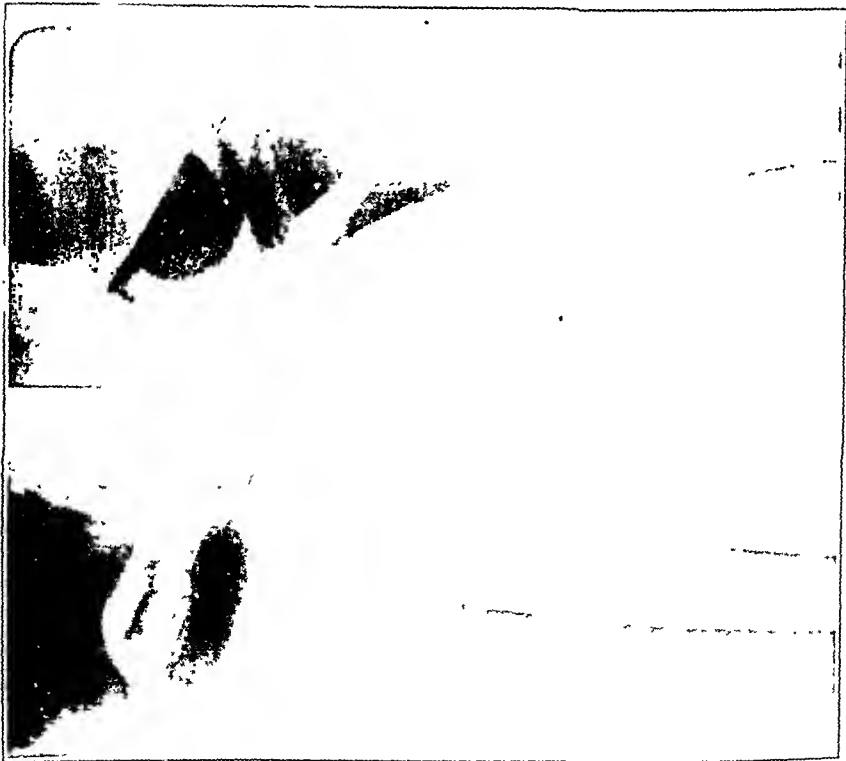


FIG. 6

August 23, 1938. Further reformation of the fibula.

Because of a mistaken diagnosis of cellulitis, conservative therapy was instituted in the form of intravenous glucose in saline, and continuous wet magnesium-sulphate dressings. On the day after admission the temperature rose to 104 degrees and remained at that level for the following two days; the pulse rate was about 140. The patient became irrational, toxic, and suffered acutely whenever the leg or the bed was touched.

During the subsequent eight days the temperature "spiked" between 99.3 and 103 degrees, and the pulse varied from 85 to 130. The patient's general condition improved, the toxæmia subsided, and the intensity of the pain diminished. Further roentgenographic studies (Fig. 2), made on July 24, 1937, showed an increase in the area of rarefaction in the metaphysis. The lateral view revealed a break in the anterior aspect of the cortex.

On August 1, 1937, it became evident that the patient was suffering from an acute osteomyelitis of the fibula, and he was transferred to the Surgical Service. In view of the diminution of toxæmia, general improvement of the patient, and the location of the disease, it was thought that surgery was not imperative, and therefore expectant treatment was continued.

The limb was immobilized in a circular plaster-of-Paris bandage, and periodic roentgenographic studies were made. The plaster-of-Paris support was continued for a period of eight months, during the latter part of which the patient was permitted to bear weight.

The temperature gradually subsided, so that, at the end of two months from the time of onset, it ranged within normal limits. The blood picture gradually approached normal, save for an anaemia which necessitated a transfusion of 250 cubic centimeters of blood during the seventh week of the illness (August 31, 1937).

An observation worthy of note was made on the occasion of the first change of the plaster-of-Paris support during the fourth week of the illness. Active dorsiflexion of the foot was absent, and the ankle jerk could not be elicited. At the same time it was noted that the leg was swollen two and one-half inches. No definite fluctuation could be demonstrated. Nevertheless, expectant treatment was continued, and on the occasion of the next change of plaster support, the neurological signs were absent. All support was discontinued on April 1, 1938.

The most recent examination, February 8, 1941, revealed slight local heat over the head of the fibula, and one-eighth of an inch thickening of the left leg at the involved level. There was no limp, no evidence of palsy, and a complete range of motion in all the joints of the extremity. At no time was there any evidence of a metastatic lesion.

ROENTGENOGRAPHIC FINDINGS

The periodic roentgenographic studies are most instructive, because of the unusual demonstration of pathological changes in the surgically undisturbed progress of the disease. On the roentgenogram (Fig. 3) of August 13, 1937, there was an evident extensive destruction of the proximal four inches of the fibula, with little periosteal reaction, save at the most distal portion of the lesion.

On the roentgenogram (Fig. 4) of October 26, 1937, the destruction of the proximal four inches of the fibula was practically complete. The associated ossified bulging periosteum could be visualized.

Roentgenographic examination (Fig. 5) made on April 1, 1938, showed that reformation of the fibula had begun. The medullary canal was beginning to reappear at the distal portion of the involved area.

Roentgenographic examination (Fig. 6) made on August 25, 1938, showed increasing reformation of the fibular shaft. The periosteal shadow was more closely approaching the fibula.

Roentgenographic examination (Fig. 7) made on September 14, 1940, showed an almost complete reformation of the shaft of the fibula. The outline of the involved portion of the shaft was somewhat irregular. There were no areas of rarefaction which would be suggestive of active disease.

"STRAIN" THROMBOSIS OF THE AXILLARY VEIN

BY HAROLD H. COHEN, M.D., NEW YORK, N. Y.

*From the Hospital for Joint Diseases, New York **

The case herewith presented is typical of a clinical entity first clearly recognized by von Schrötter in 1884, and should be distinguished from thrombosis or thrombophlebitis caused by direct external injury. In this country, it was not until 1931 that Clute reported the first two cases. This was soon followed by a rapid succession of case reports by Matas, Barker, Kaplan, etc. The lesion is predominantly a disease of the right arm of young, robust, hard-working males. It comes on rather acutely either immediately or a few hours after some sudden strain of the arm, or after physical effort or exercise which may be unusually severe or of an unusual type. In some cases a history of indirect trauma cannot be elicited.

CASE REPORT

G S., male, aged twenty-seven, was first seen on November 1, 1940, when the following history was obtained: On

June 27, 1939, while demolishing the balcony of a theater, the reinforcement wires were cut, and the patient dropped about thirty feet to the ground. There was no loss of consciousness, and he was admitted by ambulance to a city hospital where he remained for two weeks. Four days after admission, black-and-blue spots appeared over the back of his right hand, elbow, and along the arm. Eleven days after the accident, he noted a prominence of the veins about the forearm and shoulder. Swelling was not a prominent feature and was present to only a slight extent. Roentgenographic examination of the entire skeleton revealed a fissure fracture of the body of the right scapula, and a fracture of the left transverse process of the first lumbar vertebra. The patient refused further hospital care and sought a private physician, who admitted him to another hospital. No treatment other than bed rest and physical therapy to the back and lower extremities was administered. On August 10, approximately six weeks after



FIG. 1

Comparative size of the arms, the right being larger than the left.

* Service of Samuel Kleinberg, M.D.

the fall, a dull pain developed in the right arm pit, and the man complained of the presence of a tender kernel-like mass in the axilla. This was accompanied by radiating knifelike pains down the arm to the hand. Attacks of numbness, lasting up to five minutes, were first noted ten to eleven weeks after the accident. The attacks of numbness came on by day or night, and were relieved temporarily by change of arm position. At about the same time, a sensation of heaviness was noted in the entire right arm. "Knot-



FIG. 2

Infra-red photography shows numerous prominent veins over the right arm, shoulder region, and chest.

ting" of the veins was noted approximately eight months after the accident. With laborious work, the patient noted that the attacks of numbness became more frequent and severe, and he was finally forced to discontinue heavy manual labor. The com-



FIG. 3

Roentgenogram taken immediately after the injection of ten cubic centimeters of diodrast into the cephalic vein. The vein bifurcates at the upper third of the humerus, and then joins with many dilated collaterals in the supraclavicular and infraclavicular regions.

plaints referable to the head, spine, and genito-urinary systems are irrelevant to the topic under discussion and will therefore be omitted.

Past history revealed a severe burn to the right thigh and hip regions at the age of three and one-half years. There was no history of any constitutional illness or previous trauma. He denied having had lues, but a history of a Neisserian infection five years previously was obtained.

Examination disclosed an enlargement of the right upper extremity from the shoulder girdle down to the tips of the fingers (Fig. 1). The measurements were as follows:

	Right	Left
At junction of arm and shoulder	12¾ inches	11¾ inches
At mid arm	12¼ inches	11½ inches
At the elbow	10 inches	10 inches
At the mid forearm	11¼ inches	10⅜ inches
At the wrist	7⅞ inches	7 inches

There was marked prominence of the superficial veins extending up to the anterior chest and axilla, as well as along the inner and front side of the arm, forearm, and wrist (Fig. 2). There was a ruborlike tint to the right arm. Elevation of the arm resulted in slow collapse of the dilated veins. With depression these filled rapidly. There was no evidence of palmar ischaemia or clubbing of the fingers of the right hand. The grip of the right hand was considerably weaker than that of the left. No tender cord was to be felt in the axilla. The pulses seemed to be of equal rate, rhythm, and volume. The right arm was colder to the touch. Glands were palpable in both axillae. The



FIG. 4

Roentgenogram taken several minutes after Fig. 3. The dye is still present in the cephalic vein and its inner bifurcation. The dilated veins in the supraclavicular and infraclavicular areas are still to be seen.



FIG. 5

Roentgenogram taken immediately after the injection of ten cubic centimeters of diodrast into the basilic vein. The vein terminates at the middle of the humerus and then loops downward. The axillary vein is not visualized. Numerous fine collaterals are to be seen crossing the humerus to reach the lateral aspect of the arm.

reflexes were not impaired, and there were no sensory disturbances to hot or cold, pin-prick, or cotton wool.

Roentgenographic examination of the chest failed to reveal any evidence of cardiac, mediastinal, or pulmonary pathology. Examination of the lower cervical region failed to reveal any evidence of any growth, or cervical rib.

Laboratory findings were as follows:

Blood Wassermann—negative

Kahn test—negative

Red blood cells—4,750,000

Hemoglobin—94 per cent.

Platelets—250,000

White blood cells—10,700

Polymorphonuclear neutrophils—86 per cent.

Lymphocytes—14 per cent.

Bleeding and coagulation times—within normal limits

Sedimentation rate—6 millimeters in 45 minutes

The blood pressure on the affected side was slightly lower than on the left side,—the right was 105 systolic and 70 diastolic, and the left was 110 systolic and 70 diastolic millimeters

of mercury. The oscillometric index paralleling the blood pressure readings showed a definite diminution on the right as compared with the left. The mid-humeral was 9 on the right and 11 on the left, and the wrist was 4 on the right and $4\frac{1}{2}$ on the left. On the contrary, the venous pressure in the right cephalic vein was elevated to 230 millimeters of water (Normal is 60 to 120 millimeters). The circulation time using ten cubic centimeters of calcium gluconate was nineteen seconds (Normal is 10 to 12 seconds). Skin temperatures measured by the electric potentiometer were definitely lower on the right side, the difference varying from 0.5 degrees to 1.2 degrees centigrade.

Examination of the right arm, pectoral, cervical, and thoracic regions after the injection of ten cubic centimeters of diodrast into the brachiocephalic vein revealed the dye in the vein on the outer aspect of the arm (Fig. 3). A second x-ray taken almost immediately after the first exposure revealed the dye to be present in a segment of the cephalic vein and also faintly visible in the superficial vein on the outer aspect of the shoulder, as well as in the jugular region and in spots infraclavicularly (Fig. 4). Ten cubic centimeters of diodrast injected into the basilic vein revealed the basilic vein up to about the junction of the lower and middle thirds of the humerus. The basilic was narrowed and not seen in the upper arm, nor was its continuation into the axillary vein seen (Fig. 5).

Though the vein was not actually visualized surgically, the history of an accident with probably indirect trauma to the axillary vein, the enlargement of the arm, the prominence of the superficial veins of the arm and anterior pectoral region, the increased number of superficial veins noted clinically and revealed by infra-red photography, the increased venous pressure, the prolonged circulation time, and the diodrast injection established a diagnosis of thrombosis of the axillary vein.

The etiology of axillary thrombosis following indirect trauma is still obscure, despite the theories advanced to account for it. There is no evidence to support the theory of an infectious or toxic lesion of the vein, and the absence of any reported changes in the clotting mechanism of the blood would appear to rule that out as a factor in the thrombosis. Most observers agree that thrombosis follows indirect trauma to the vein,—such as a shoulder strain. This may come from an abduction, extension, or rotary injury of the arm. Such an accident may be of sudden or more gradual onset. The so-called idiopathic cases are believed to be the result of recurrent minimal trauma which is unnoticed by the patient. This trauma was first believed to be a sudden stretching or compression of the distended vein, and more recently has been regarded as a contusion of the vein over the first rib by the subclavius and costocoracoid ligament. Gould and Patey feel that the subclavius causes a rupture of a delicate valve at the level of the muscle. This rupture, according to them, is the fundamental basis for the thrombosis. Several cases have been reported in which, at operation, only a spastic vein was found. The sympathetic theory, advanced by Cottalorda of Marseille (1932), was based on just such a pathological finding at operation. This author feels that the lesion has its origin in a venospasm, induced by sympathetic irritation caused by trauma. Thrombosis may or may not follow. Matas feels that the thrombosis is a complex syndrome of multiple causation in which indirect trauma of the axillary vein, with its surrounding lymphatics and sympathetic plexus, plays the leading rôle.

Prognosis: This is good with regard to life. The duration of the disability is variable; there may be a complete return of function in several months, but, in the majority, the convalescence is prolonged, lasting many months. Recurrent attacks of oedema, weakness, and stiffness may follow prolonged exertion, so that these patients do best with change of occupation. Recovery indicates adequate collateral circulation with possible canalization of the thrombus.

Treatment: In the majority of cases the patients have been relieved during the acute stage by rest, bandaging, elevation, leeches, physical therapy, and other methods of local care applied in the treatment of phlebitis. Some authors have advised thrombectomy or excision of the entire segment of the spastic vein, when found. In the case here presented, no treatment other than a change of occupation was found necessary.

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FRACTURE-DISLOCATION OF THE HIP

BY VERNON L. HART, M.D., MINNEAPOLIS, MINNESOTA
University of Minnesota Medical School

Watson-Jones¹ states: "Sixteen dislocations of the hip have been associated with fracture of the neck of the femur. After such an injury, operative reduction must inevitably cause necrosis of the detached head. It is better, therefore, if manipulative reduction has failed, to excise the loose head and, after downward displacement of the trochanter, to place the neck of the femur in the joint as in a Whitman reconstruction operation."

The author wishes to report an additional case which was treated by open operation as advised by Watson-Jones. Three years after operation, examination demonstrated a most gratifying functional result with bony ankylosis of the hip.

B. W., male, aged forty-six, was injured seriously in an unusual accident on October 24, 1938. He was horseback riding when the door handle of an automobile passing at considerable speed in the opposite direction caught in the right stirrup. When the ambulance arrived, the physician found the patient unconscious and in profound shock, with a compound fracture of the right patella and a major injury of the right hip.



FIG. 1

Radiograph on November 22, 1938, demonstrating complete fracture through the neck of the femur (upper arrow) and complete dislocation of the head of the femur from the acetabulum (lower arrow). There is also evidence of arteriosclerosis and organization of hematoma near the socket.

The author first examined the patient on the following day. He was then conscious, mentally clear, and free from any evidence of shock. On the same day the author treated the compound fracture of the patella by débridement, mechanical cleansing, excision of the entire fragmented patella, suture of the capsule, and primary closure of the wound. The extremity was suspended in traction by means of a Hodgen splint. There was no postoperative infection of the wound.

Examination of the right hip revealed a tremendous hematoma involving the entire hip region and upper thigh. There was two inches of shortening of the extremity. There was no paralysis. Roentgenographic studies (Figs. 1 and 2) on November 22, 1938 revealed a complete fracture through the neck of the femur, and a complete dislocation of the head of the femur from the acetabulum.

Thirty-one days after injury, the fracture-dislocation of the hip was treated by open operation. The hip joint was exposed through the Watson-Jones anterolateral approach. The femoral head, which

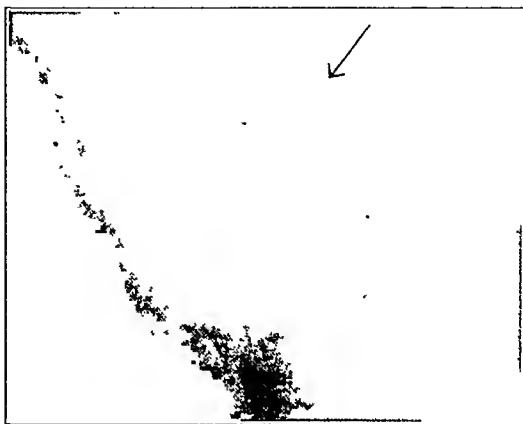


FIG. 2

Lateral roentgenogram on November 22, 1938, showing the head of the femur dislocated downward and anteromedial to the femoral shaft.



FIG. 3

Roentgenogram on October 18, 1941, three years after surgical removal of the femoral head and Whitman reconstruction operation. There is evidence of bony ankylosis of the hip joint, resulting from calcification and ossification of hematoma and articular damage.

was displaced downward and anteromedial to the femoral shaft, was removed from the wound. A Whitman reconstruction procedure was then done. There was considerable evidence of the extensive hematoma within and about all soft-tissue structures. After primary closure of the wound, the hip was splinted in a short plaster spica in 30 degrees of abduction and 15 degrees of flexion. There were no complications, and the patient was discharged, walking with crutches and spica, on December 19, 1938.

Ankylosis of the hip in a good functional position was noted when the hip spica was removed. Ankylosis resulted from calcification and ossification of the extensive hematoma and injury to the articular cartilage of the acetabulum.

The patient returned to his work as a foreman in a power company in the spring of 1939, and has worked continuously since then without pain or complaints. He was last examined by the author on October 18, 1941, when he walked without any form of support and with a good gait. Roentgenographic studies (Fig. 3) and clinical examination demonstrated solid bony ankylosis of the hip in a good functional position with 15 degrees of abduction, 20 degrees of flexion, and slight external rotation.

1. WATSON-JONES, R.: *Fractures and Other Bone and Joint Injuries*. Ed. 2, p. 463. Baltimore, Williams & Wilkins Co., 1941.

THE USE OF THE CAMPBELL-BOYD PNEUMATIC TOURNIQUET FOR SPINE-FUSION PROCEDURES

BY LOUIS W. BRECK, M.D., AND W. COMPERE BASOM, M.D., EL PASO, TEXAS

In those spine-fusion procedures in which a tibial graft is used, considerable hemorrhage often occurs during the removal of the graft. Even if bleeding is controlled with hemostatic forceps or clamps, there is a definite loss of blood and time, which can be eliminated by the use of a tourniquet on the extremity. The ordinary type of tourniquet is not suitable, because it must be applied at the beginning of the operation and cannot be released when the work on the extremity is finished, without disturbing the drapes.

For the past year, one of the authors has used the Campbell-Boyd pneumatic tourniquet¹ in all spine-fusion procedures in which a tibial graft was necessary. This apparatus consists of a cloth-covered rubber cuff, similar to that of a sphygmomanometer, which can be buckled in place on the extremity. The zipper has been replaced with buckles because they are more reliable. A heavy rubber tubing, which is long enough to reach to the head of the operating table, connects the cuff with a pump and pressure gauge. The cuff of the tourniquet can be buckled in place before the anaesthetizing is begun. The tubing is placed alongside the patient, and the gauge and pump are fastened at the head of the table where the anaesthetist can easily control the pressure. The patient is then anaesthetized, prepared, and draped. The operative procedure may be started at any time on the leg. The anaesthetist can easily inflate the tourniquet to the desired pressure to secure adequate hemostasis. As soon as the surgery is completed on the extremity, the pressure can be released simply by opening a small valve on the manometer. Thus the tourniquet has to be used only during the actual removal of the graft and not for the total time of the spine-fusion procedure.

The disadvantages of this use of the tourniquet are as follows:

It is necessary to have two different lengths of tourniquets to fit the various sizes of extremities, though this item has been found unimportant.

There is also the possibility of a tourniquet paralysis. However, with the application of a correctly determined, exact amount of pressure distributed evenly over a large area, this complication is a negligible factor. Ordinarily six pounds of pressure is used for the small children, nine pounds for larger children, and twelve pounds for adults.

Advantages of this tourniquet are as follows:

Exact amount of pressure may be applied evenly over a large area.

The tourniquet may be easily inflated and quickly deflated at any time without disturbing the sterile surgical drapes or the operator.

There is no blood loss during the removal of the tibial graft, and the tendency toward shock is lessened because of this.

1. CAMPBELL, W. C., AND BOYD, H. B.: A Pneumatic Tourniquet. *J. Bone and Joint Surg.*, XIX, S32, July 1937.

RUBBER-SURFACE SKIN TRACTION

BY HAMILTON I. BARNARD, M.D., DENVER, COLORADO

This method of traction is not meant to replace simple adhesive traction in the usual type of cases. However, it is found very advantageous in cases where adhesive traction is found inadequate or unsatisfactory, especially where there is skin irritation or where, as in the convalescent stage of infantile paralysis, it is necessary to remove the traction daily for the purpose of physical therapy. As the illustrations show, the method of application is the same as for ordinary adhesive traction.

Figure 1 shows the materials used,—that is, adhesive straps with sponge rubber attached, elastic roller bandage, foot plate, weights, weight holder, and rope. The adhesive straps with webbing attached are cut to the right size. Sponge rubber three-eighths of an inch thick is cut the same size as the adhesive straps and is applied to the adhesive, or the sponge rubber may be glued to plain webbing straps. The skin may or may not be painted with compound tincture of benzoin. The straps are then placed against the extremity as shown in Figure 2, and are held in position by some type of a roller elastic bandage. (See Figure 3.) The rubber comes down well over the malleoli.

This type of traction can be used on either the lower or the upper extremity, and in all types of cases. It can be easily and quickly ad-

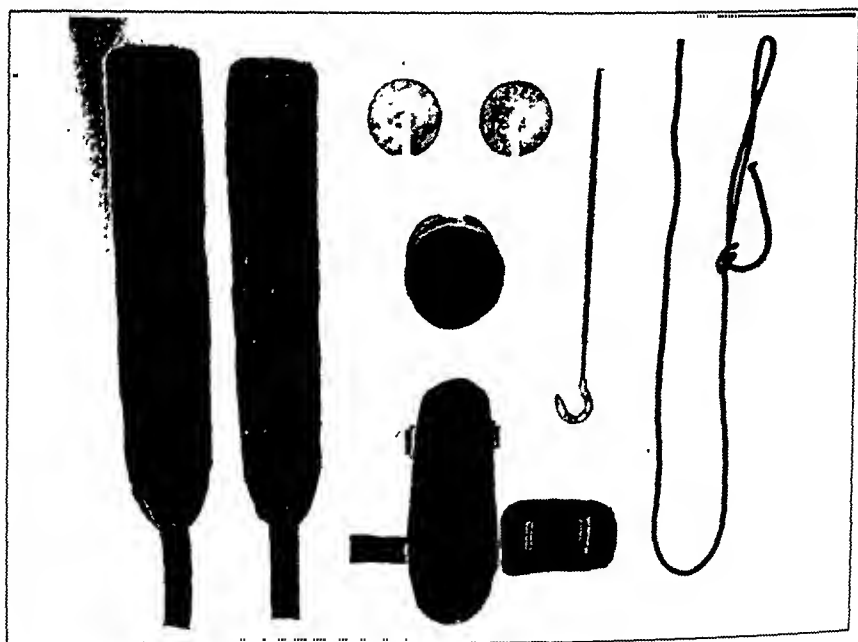


FIG. 1

Material used for rubber-surface skin traction: adhesive straps with sponge rubber attached, foot plate, roller bandage, weights, weight holder, and rope.

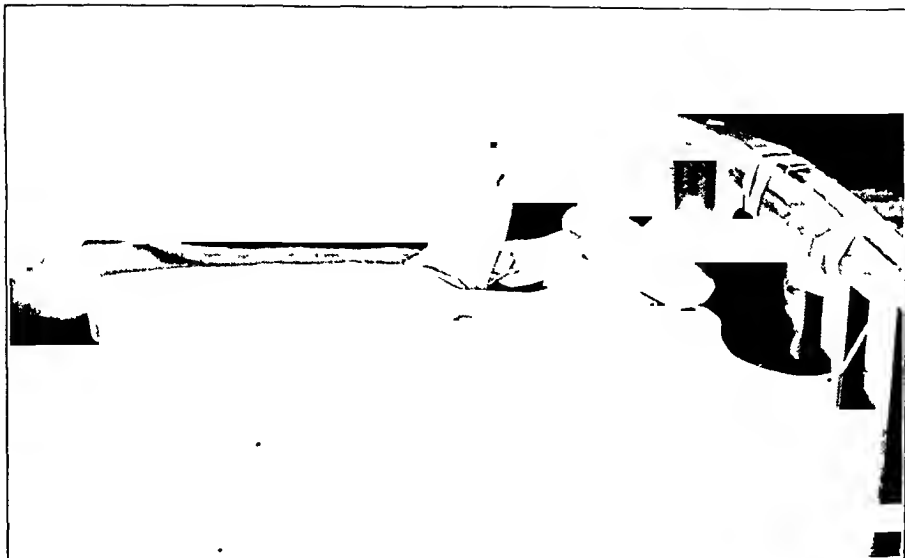


FIG. 2

Straps are placed against the leg in the proper position.

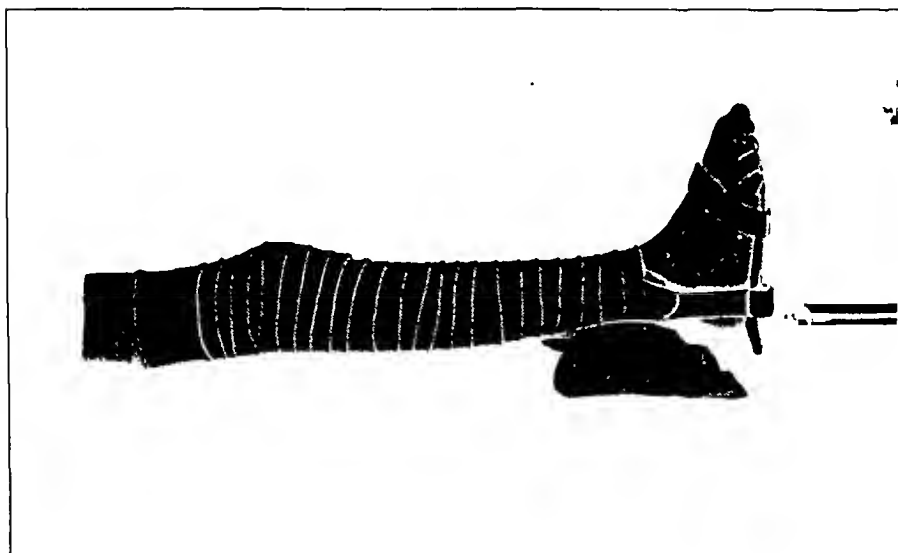


FIG. 3

Traction is completed with the foot plate attached.

justed. On the lower extremity, as much as twenty pounds can be applied with very little slipping. It is also desirable to have a long foot plate or spreader which can be adjusted for different leverages on the foot.

The advantages of this traction are: The adhesive tape can be eliminated entirely; the sponge straps can be used over and over after proper cleansing and they can be removed daily for physical therapy; there is not the irritation of the skin that is often found in adhesive traction; and this type of traction is readily adjusted.

A NEW MARKER FOR SPINE SURGERY

BY JOSEPH D. WASSERSUG, M.D., SOUTH BRAINTREE, MASSACHUSETTS

From the Lakeville State Sanatorium, Middleboro, Massachusetts

In practically all operations upon the spine it is necessary to identify accurately the vertebral bodies that are being operated upon. Skin markers, such as silver nitrate, are inadequate because they may become effaced when the back is prepared for operation. Besides, such markers are concealed when the skin edges of the operative wound are covered by towels. Another type of marker recently used in some hospitals is a needle that is inserted preoperatively into the spinous process and then broken off. Although this method gives accurate visual and roentgenographic localization of the site of operation, it is not without some hazard.

Recently Betts, and Overholt and Rumel described the use of a mixture of lipiodol and carbon which is injected into an intercostal muscle, thus providing roentgenographic localization and a visual landmark in operations for pulmonary abscess. Lipiodol and lampblack were used after other combinations of radiopaque and easily visualized materials were tested and found to be less satisfactory.

Modifying the technique described by them, two to three minims of a one-per-cent. suspension of lampblack in lipiodol (40 per cent. iodine) is injected subcutaneously over the spinous process that is to serve as the landmark. The lipiodol and lampblack mixture is autoclaved once, and if proper precautions are employed, may remain sterile indefinitely. To insure a uniform distribution of carbon particles it is advisable to shake the mixture just before using. A hypodermic syringe or a tuberculin syringe and a 22- or 23-gauge needle, one and one-half inches long, are used. It is not necessary to anaesthetize the site of injection with procaine, but this may be done optionally.

The spinous process that is to serve as a landmark is localized by palpation under aseptic precautions and the needle is inserted, until it is felt to touch the spinous process, when it is slightly withdrawn and the lipiodol and carbon mixture is injected. Two to three minims of mixture is all that is necessary, and care must be taken to see that larger quantities are not used, since it is not advisable to have the material diffuse over too great an area. Roentgenograms are then taken. The lipiodol can be seen on the roentgenograms, and the lampblack shows up clearly at the time of operation.

This technique has been successfully carried out on fifteen patients. The ages of the patients varied from six to forty-eight years, and there were ten females and five males in the series. Twelve patients had tuberculosis of the spine, and the lipiodol and carbon markers were used in preparation for an arthrodesis. The three remaining patients had

infantile paralysis. One of these had a scoliotic spine, and the lipiodol and carbon mixture was injected to serve as a landmark for a spine fusion. The other two patients had a pseudarthrosis following a spine arthrodesis for scoliosis. The lipiodol and carbon were used as markers for the pseudarthrosis and a successful repair was later carried out.

The time between injection of lipiodol and carbon and the operation varied from three to fourteen days. In all but one case the carbon was recognized easily at operation. In only one case was it necessary to inject the patient twice because too small a quantity to permit roentgenographic visualization had first been used. In no case did infection or inflammation develop at the site of the injection either preoperatively or postoperatively. An occasional patient has complained of a slight amount of pain following injection, but this was readily controlled by aspirin.

SUMMARY

A one-per-cent. suspension of lampblack in lipiodol, injected subcutaneously and intramuscularly, is a safe and convenient marker for operations on the spine. It combines accurate roentgenographic localization with ready visualization at the time of operation.

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News Notes

The American Association of Industrial Physicians and Surgeons and the American Industrial Hygiene Association will hold their joint Annual Convention in Cincinnati, April 13 to 17, 1942.

The American Physiotherapy Association will hold its Twenty-First Annual Convention at Lake Geneva, Wisconsin, June 28 to July 3, 1942.

The dedication of the new Professional Service Building at the Hospital for Joint Diseases, New York (the Melanie Faith Polachek Cournand Memorial), took place on Saturday, February 7. This building will be a valuable addition to the Hospital.

Dr. Julius Hass, who formerly occupied the Chair of Orthopaedic Surgery at the University of Vienna, has been appointed Attending Orthopaedic Surgeon, in charge of the Orthopaedic Service, at Montefiore Hospital, New York City.

Dr. Luthero Vargas, eldest son of the President of Brazil, is in this country on a mission from the municipality of Rio de Janeiro, to study and investigate methods of North American hospitals with a view to establishing in that city a charity wing of 100 beds, exclusively for the treatment of school children. This is to be connected with the Centro Medico Pedagogico "Oswaldo Cruz", of which Dr. Vargas is chief surgeon in the orthopaedic department.

Extra copies of "Progress in Orthopaedic Surgery for 1940", published in the September, October, and November 1941 numbers of *Archives of Surgery*, are available at \$1.00 per copy, from the office of the Editor, Box 269, Wilmington, Delaware. This is a most comprehensive review of the orthopaedic literature for the year 1940.

A small group of orthopaedic surgeons of Eastern New York State and Western New England have recently formed a local orthopaedic group. They have chosen for the name of their organization, "The Nicholas André Society", for André, who in 1741 first used the term "orthopaedia". Meetings are held once a month at the offices or homes of the members. At each meeting, the host may demonstrate patients, offer a scientific presentation, or lead a round-table discussion of an announced subject. The scientific program is followed by a social hour.

Because of the war, the Thirty-Second Annual Clinical Congress of the American College of Surgeons will be held in Chicago, October 19 to 23, 1942, instead of in Los Angeles as originally planned. Headquarters will be at the Stevens Hotel. The Twenty-Fifth Annual Hospital Standardization Conference, sponsored by the College, will be held simultaneously. The programs of both meetings will be based chiefly on wartime activities as they affect surgeons and hospital personnel in military and civilian service.

CONSERVATION OF MEDICAL JOURNALS

The American Library Association created this last year the Committee on Aid to Libraries in War Areas, headed by John R. Russell, the Librarian of the University of Rochester. The Committee is faced with numerous serious problems, and hopes that American scholars and scientists will be of considerable aid in the solution of some of these problems.

One of the most difficult tasks in library reconstruction after the first World War was that of completing foreign institutional sets of American scholarly, scientific, and technical periodicals. The attempt to avoid a duplication of that situation is now the concern of the Committee.

Many sets of journals will be broken by the financial inability of the institutions to renew subscriptions. As far as possible they will be completed from a stock of periodicals being purchased by the Committee. Many more will have been broken through mail difficulties and loss of shipments, while still other sets will have disappeared in the destruction of libraries. The size of the eventual demand is impossible to estimate, but requests already received by the Committee give evidence that it will be enormous.

In view of an imminent paper shortage, attempts are being made to collect old periodicals for pulp. Fearing this possible reduction in the already limited supply of scholarly and scientific journals, the Committee hopes to enlist the cooperation of subscribers to this Journal in preventing the sacrifice of this type of material to the demand for pulp.

It is scarcely necessary to mention the appreciation of foreign institutions and scholars for the activity of the Association in meeting this need.

Questions concerning the project or concerning the value of particular periodicals to the project should be directed to Wayne M. Hartwell, Executive Assistant to the Committee on Aid to Libraries in War Areas, Rush Rhees Library, University of Rochester, Rochester, New York.

THE AMERICAN ORTHOPAEDIC ASSOCIATION

The Fifty-Sixth Annual Meeting of **The American Orthopaedic Association** will be held at Baltimore and Virginia Beach, June 3 through June 5, 1942, under the presidency of Dr. George E. Bennett. Present plans are for the meeting on June 3 to be held in Baltimore, the members and guests leaving that evening by chartered boat for Virginia Beach where the scientific and executive sessions will be held on Thursday and Friday, at the Cavalier Hotel. The party will return to Baltimore by boat on Friday night. Should circumstances make the boat trip inadvisable, the entire meeting will be held in Baltimore.

The tentative program as submitted by the Program Committee is as follows:

WEDNESDAY, JUNE 3, BALTIMORE

Morning Session

Clinical presentation by Dr. George E. Bennett and Associates.

Noon

First Executive Session.

Afternoon Session

War Surgery.

Col. J. A. MacFarlane, Surgical Consultant to Canadian Active Service Force.
Pin Fixation of War Fractures.

Dr. Wallace H. Cole, St. Paul, Minnesota.

Report by Dr. Guy W. Leadbetter, Washington, D. C., Chairman of Combined Military Committees of The American Orthopaedic Association and The American Academy of Orthopaedic Surgeons.

Metal Internal Fixation in Lumbosacral Fusion.

Dr. Philip D. Wilson, New York, N. Y.

Indications for the Intravenous Use of Amino Acid Mixtures in Surgery.

Dr. Lee E. Farr, Director of Research of the Alfred I. duPont Institute of the Nemours Foundation. (By invitation.)

THURSDAY, JUNE 4, VIRGINIA BEACH

Morning Session

End Results of Treatment of Poliomyelitis in Baltimore.

Dr. George E. Bennett, Baltimore, Maryland.

Dr. R. E. Lenhard, Baltimore, Maryland. (By invitation.)

End Results of Treatment of Poliomyelitis in Detroit.

Dr. Charles W. Peabody, Detroit, Michigan.

End Results of Treatment of Poliomyelitis in Toronto.

Dr. W. J. Gardiner, Toronto, Ontario, Canada. (By invitation.)

Departures from the Principles of Absolute Fixation in the Treatment of Anterior Poliomyelitis.

Dr. Arthur Steindler, Iowa City, Iowa.

Spasticity of Muscles in Anterior Poliomyelitis.

Dr. R. Plato Schwartz, Rochester, New York.

Discussion opened by Dr. Wallace H. Cole and Dr. Frank R. Ober.

A Method of Measuring Strength of Trunk Muscles.

Dr. Leo Mayer, New York, N. Y.

Arthrodesis of the Paralytic Shoulder.

Dr. Paul C. Colonna, Oklahoma City, Oklahoma (for Dr. Joseph S. Barr, Boston, Massachusetts, Chairman of the Research Committee).

Arthrodesis of the Wrist Joint.

Dr. LeRoy C. Abbott, San Francisco, California.

Post-Metastatic Survival of Osteogenic Sarcoma.

Dr. Kellogg Speed, Chicago, Illinois.

Afternoon

Annual Golf Tournament.

Evening

Annual Dinner.

FRIDAY, JUNE 5, VIRGINIA BEACH

Morning Session

Compound Fractures.

Dr. Arthur G. Davis, Erie, Pennsylvania.

Spondylolisthesis.

Dr. Henry W. Meyering, Rochester, Minnesota.

Discussion opened by Dr. R. I. Harris.

Congenital Dislocation of the Hip.

Dr. A. Bruce Gill, Philadelphia, Pennsylvania.

Spontaneous Fracture of the Femur Following Radiation Therapy for Pelvic Malignancy.

Dr. Carl E. Badgley, Ann Arbor, Michigan.

Discussion opened by Dr. W. E. Gallie.

The Healing of Fractures.

Dr. Robert W. Johnson, Jr., Baltimore, Maryland.

Dr. Marshall R. Urist, Baltimore, Maryland. (By invitation.)

Discussion opened by Dr. J. Albert Key.

Malignant Vascular Tumors of Bone.

Dr. Atha Thomas, Denver, Colorado.

Discussion opened by Dr. Dallas B. Phemister.

Noon

Second Executive Session.

Afternoon Session

President's Address.

Dr. George E. Bennett, Baltimore, Maryland.

Osteomyelitis and Its Treatment by Sulfonamide Drugs.

Dr. John C. Wilson, Los Angeles, California.

Fracture of the Odontoid Process.

Dr. W. E. Gallic, Toronto, Ontario, Canada.

The Use of Steel Wires for Retention of Bone Fragments.

Dr. A. W. Farmer, Toronto, Ontario, Canada. (By invitation.)

Etiology of Aseptic Necrosis of the Head of the Femur Following Fracture.

Dr. Edward L. Compere, Chicago, Illinois.

Discussion opened by Dr. Dallas B. Phemister and Dr. J. Albert Key.

An Operation for the Correction of Acromioclavicular Dislocation.

Dr. Luthero Vargas, Rio de Janeiro, Brazil. (By invitation.)

Local Anaesthesia in Spine Surgery.

Dr. Joseph A. Freiberg, Cincinnati, Ohio.

Discussion opened by Dr. J. H. Kite and Dr. Ralph K. Ghormley.

THE AMERICAN ACADEMY OF ORTHOPAEDIC SURGEONS

The Tenth Annual Convention of **The American Academy of Orthopaedic Surgeons** was held at the Chalfonte-Haddon Hall Hotel, Atlantic City, New Jersey, January 11, 12, 13, 14, and 15, 1942, under the presidency of Dr. Oscar Lee Miller, of Charlotte, North Carolina. The meeting was one of the most successful, with a registration of over 800. The instructional courses proved exceptionally interesting and popular, and it was decided that similar courses should be a feature of the 1943 meeting.

The scientific program included the following papers:

MONDAY, JANUARY 12

Morning Session

Two Cases of Late Rupture of the Extensor Pollicis Longus Tendon Following Colles' Fracture—Dr. Edwin Weinberg, Baltimore, Maryland.

The Steinmann Pin in Fracture Fixation—Dr. O. Anderson Engh, Washington, D. C.

A Report of Thirty Cases of Osteochondritis Dissecans—Lt. Comdr. Robert Mazet, Jr., U.S.N.

The Army Medical Corps—Col. George Lull, U.S.A. (By invitation.)

The Clinical Use of the Chamberlain Technique in Back Examinations—Dr. Randolph L. Anderson, Charleston, West Virginia.

Vitallium Replacement of Upper Two-Thirds of Femur, Following Nailing for Non-Union of Neck of Femur, Subsequent Bone Graft for Giant-Cell Tumor, and Finally Resection of Bone—Dr. Austin T. Moore, Columbia, South Carolina.

Congenital Synostosis of the Cervical Spine (Klippel-Feil Syndrome). A Study of Case Reports—Dr. H. Alvan Jones, Baltimore, Maryland.

Two Cases of Interscapulothoracic Amputation—Major Leonard T. Peterson, U.S.A.

Afternoon Session

The Treatment of Fracture and Dislocation of the Cervical Spine—Dr. William A. Rogers, Boston, Massachusetts.

Treatment of Flexion Deformities of the Knee—Dr. Rudolph S. Reich, Cleveland, Ohio.

Pathology of Recurrent Dislocation of the Shoulder; Report of Bankhart's Operative Procedure—Dr. Frederick C. Bost and Dr. Verne T. Inman (by invitation), San Francisco, California.

TUESDAY, JANUARY 13

Morning Session

- Eosinophilic or Solitary Granuloma—Is It a New Disease?—Dr. William T. Green and Dr. Sidney Farber (by invitation), Boston, Massachusetts.
- Rate and Amount of Increase in Muscle Strength Following Infantile Paralysis—Dr. Robert L. Carroll, Los Angeles, California.
- The Obturator Sign as the Earliest Roentgenographic Evidence of Hip Joint Infection—Dr. Herman C. Selhum, Dr. Vernon C. Turner (by invitation), and Dr. Hans W. Hefke (by invitation), Milwaukee, Wisconsin.
- A Study of Gross and Microscopic Lesions in Tuberculosis of the Spine—Dr. Mather Cleveland and Dr. David M. Bosworth, New York, N. Y.

Afternoon Session

- Prevention of the Hereditary Crippling Diseases—Dr. William Allan, Charlotte, North Carolina. (By invitation.)
- Calcification and Ossification of Semilunar Cartilages—Dr. James B. Weaver, Kansas City, Missouri.
- The Role of Articular Cartilage in Hypertrophic Arthritis—Dr. George Wagoner, Haverford, Pennsylvania.

WEDNESDAY, JANUARY 14

Morning Session

- What is Actually the Best Treatment of Acute Osteomyelitis?—Dr. Pedro S. Toledo, Havana, Cuba.
- Experimental Osteomyelitis—Dr. Philip Lewin and Dr. Louis Seheman (by invitation), Chicago, Illinois.
- The Value of the Laminograph in the Treatment of Chronic Osteomyelitis—Dr. Alan DeForest Smith and Dr. Lawson E. Miller (by invitation), New York, N. Y.
- The Report of the Use of Sulfonamides in Traumatic and Infected Wounds—Dr. Lenox D. Baker, Durham, North Carolina.
- Treatment of Club Feet with Denis Browne Splints—Dr. Stuart A. Thomson, Toronto, Canada. (By invitation.)

Afternoon Session

- The Management of Associated Injuries in the Presence of Skull Fracture—Dr. Harry E. Mock, Chicago, Illinois.
- President's Address—Dr. Oscar Lee Miller, Charlotte, North Carolina.
- Fusion of the Metacarpal of the Thumb and Index Finger to Maintain Functional Position of the Thumb—Dr. Charles F. Thompson, Indianapolis, Indiana.

THURSDAY, JANUARY 15

Morning Session

- Extra-Articular Fixation and Bone-Grafting of Fractures of the Hip. Preliminary Report—Dr. Juan Farill, Mexico City, Mexico.
- The Orthopaedic Treatment of Hypertrophic Arthritis of the Hip—Dr. John G. Kuhns, Boston, Massachusetts.
- Surgical Treatment of Painful Hips in Adults—Dr. Ralph K. Ghormley and Dr. Mark B. Coventry (by invitation), Rochester, Minnesota.
- Further Report on the Kenny Treatment of Infantile Paralysis—Dr. Wallace H. Cole, St. Paul, Minnesota.

An important feature of the program this year was the "refresher" courses which were given on Tuesday and Wednesday mornings and on Monday, Tuesday, and Wednesday afternoons. The subjects of these instructional courses, and the faculty, were:

Lame Back: Drs. Ober, Ferguson, Kubik, Chamberlain, Nichols, Brown, Rogers, Hampton, Hansson, Smith, Lewin, Badgley, Steindler, Dickson, and Ghormley.

Röntgen Therapy: Dr. Pendergrass.

Fractures: Drs. Conwell, Murray, Anderson, McBride, Speed, Johnson, and White.

Arthritis: Drs. Swaim, Dickson, Ferguson, Hench, and Shands.

Knee Joint: Drs. Bennett, Voshell, Mauck, Bosworth, and Brantigan.

Vitallium-Mold Arthroplasty: Dr. Smith-Petersen.

Bone Metabolism: Drs. Gill and Stein.

Surgery of the Hand: Dr. Bunnell.

Disability Evaluation: Dr. Magnuson.

Foot Disabilities: Drs. Lewin, Morton, Diveley, Ober, Hauser, McBride, Miller, Hart, Steindler, Barber, Speed, Compere, Schwartz, Kirk, Schrock, Hobart, Phelps, Orr, Sloat, Heyman, Hallock, Freiberg, Shands, and Mayer.

Scoliosis: Drs. Smith, Ferguson, Steindler, Cobb, von Lackum, and Risser.

Bone Tumors: Drs. Murphy and Ramsey.

Periarthritis of the Shoulder: Dr. Dickson.

War Surgery: Drs. Cole, Waknitz, and Dial.

Club Foot and Congenital Deformities: Dr. Kite.

There were a large number of motion pictures given before and following the scientific sessions. These covered many subjects of interest to the attending surgeons.

The scientific exhibits were of a high order. These were in charge of a committee of which Dr. Julius S. Neviasser, of Washington, D. C., was Chairman.

There were also many commercial exhibits, and Dr. Frank M. Hand was Chairman of the committee in charge.

Dr. J. E. M. Thomson was Chairman of the Program Committee, Dr. Guy W. Leadbetter was Chairman of the Local Arrangements Committee, and Dr. Custis Lee Hall, of the Local Program Committee.

A very enjoyable social program was planned by the President.

After the Annual Banquet, held on Wednesday evening, January 14, in the Chalfonte Dining Room, the following awards were made for scientific exhibits:

Gold medal for Originality of Presentation of Research Problems, to Dr. James B. Weaver and Dr. Mary W. Tyler, of Kansas City, Missouri; Title of exhibit, "Hematogenous Staphylococci Osteomyelitis. Clinical, Immunological, and Experimental Studies."

Gold medal for Scientific Importance and Information, to Dr. J. T. Murphy and Dr. C. E. Hufford, of Toledo, Ohio; Title of exhibit, "Bone Pathology. Clinical Correlation with Radiological and Pathological Findings."

Gold medal for Clinical Value, to Dr. Walter A. Hoyt and Dr. Adrian Davis, of Akron, Ohio; Title of exhibit, "Acute Osteomyelitis. Non-Operative Treatment by Sulfathiazole."

Certificates of merit were awarded to the following for their exhibits:

Dr. William T. Green and Dr. Sidney Farber, of Boston, Massachusetts—"Eosinophilic or Solitary Granuloma. Is It a New Disease?"

Dr. Vernon L. Hart, of Minneapolis, Minnesota—"Dysplasia of the Hip Joint, With and Without Dislocation".

Dr. William Allan, of Charlotte, North Carolina—"Survey in North Carolina of Hereditary Crippling Diseases". (Miss Pearl Dudley, in charge of Field-Work Exhibits.)

Dr. Mather Cleveland, Dr. David M. Bosworth, and Dr. Sumner Price, of New York, N. Y.—"Tuberculous Pathology of Spine, Gross and Microscopic".

Dr. Roger Anderson, of Seattle, Washington—"Intertrochanteric Fractures and Non-Union of the Neck of the Femur".

Dr. James A. Dickson and Dr. William A. Nosik, of Cleveland, Ohio—"Thorotrast Myelography. Experimental and Clinical Studies".

Certificates of membership were given to the following new Fellows:

Dr. George Thomson Aitken, Grand Rapids, Michigan.
 Dr. George Clarence Battalora, New Orleans, Louisiana.
 Dr. Harry Archer Berman, Boston, Massachusetts.
 Dr. H. H. Boucher, Vancouver, British Columbia.
 Dr. Abraham S. Browdie, Pittsburgh, Pennsylvania.
 Dr. Alvin Rich Carpenter, Binghamton, New York.
 Dr. Eldon George Chuinard, Portland, Oregon.
 Dr. William Cooper, Brooklyn, New York.
 Dr. Edward G. Ewer, Oakland, California.
 Dr. Erasmus D. Fenner, New Orleans, Louisiana.
 Dr. Charles H. Frantz, Alexandria, Louisiana.
 Dr. John H. Galbraith, Altoona, Pennsylvania.
 Dr. Nicholas J. Giannestras, Cincinnati, Ohio.
 Dr. Charles W. Gilfillan, Los Angeles, California.
 Dr. Wayne R. Glock, Fort Wayne, Indiana.
 Dr. George Hammond, Ann Arbor, Michigan.
 Dr. John E. Hanby, Washington, D. C.
 Dr. Frank C. Hodges, Abilene, Texas.
 Capt. F. R. Hook, M.C., U.S.N., Washington, D. C.
 Dr. William A. Horan, Providence, Rhode Island.
 Dr. Harry C. Hughes, Denver, Colorado.
 Dr. Jay L. Hutchison, Huntington, West Virginia.
 Dr. Frank S. Jones, Hartford, Connecticut.
 Lt. Frank P. Kreuz, Jr., M.C., U.S.N., Quonset Point, Rhode Island.
 Dr. Henry B. Lacey, Columbus, Ohio.
 Dr. Claude N. Lambert, Chicago, Illinois.
 Dr. John F. Lovejoy, Jacksonville, Florida.
 Dr. Gilbert J. McKelvey, Portland, Oregon.
 Dr. I. S. McReynolds, Houston, Texas.
 Dr. Foster Matchett, Denver, Colorado.
 Dr. Newton C. Mead, Evanston, Illinois.
 Dr. Bernard J. Mintz, New York, N. Y.
 Dr. John R. Naden, Vancouver, British Columbia.
 Dr. Alonzo J. Neufeld, Los Angeles, California.
 Dr. Tom Outland, Harrisburg, Pennsylvania.
 Major Leonard T. Peterson, M.C., U.S.A., Washington, D. C.
 Dr. Walter R. Peterson, Trenton, New Jersey.
 Dr. Edward K. Prigge, Los Angeles, California.
 Dr. Victor Raisman, Richmond Hill, New York.
 Dr. Maurice B. Roche, St. Louis, Missouri.
 Dr. Manley B. Shaw, Boise, Idaho.
 Dr. Howard B. Shorbe, Oklahoma City, Oklahoma.
 Dr. Lawrence C. Snow, Salt Lake City, Utah.
 Dr. Francis E. West, San Diego, California.
 Dr. Harry Winkler, Charlotte, North Carolina.
 Dr. Charles J. Zinn, Philadelphia, Pennsylvania.

Four doctors were elected to Honorary Membership: Dr. José Valls, Buenos Aires, Argentina; Dr. Herman de las Casas, Caracas, Venezuela; Dr. Eugenio Diaz-Lira, Santiago, Chile, and Dr. William E. Gallie, Toronto, Ontario.

Executive Sessions were held on Monday and on Thursday. At the last Session, the new President, Dr. Carl E. Badgley, was introduced, and new officers were elected.

The officers of the Academy are:

President: Dr. Carl E. Badgley, Ann Arbor, Michigan.
President-Elect: Dr. M. N. Smith-Petersen, Boston, Massachusetts.
Vice-President: Dr. Robert V. Funsten, Charlottesville, Virginia.
Treasurer: Dr. E. Bishop Mumford, Indianapolis, Indiana.
Secretary: Dr. Rex L. Diveley, Kansas City, Missouri.
Librarian-Historian: Dr. Philip Lewin, Chicago, Illinois.

The Palmer House, in Chicago, Illinois, has been selected as the headquarters for the next Annual Meeting, January 17 to 21, 1943.

THE BRITISH ORTHOPAEDIC ASSOCIATION

The British Orthopaedic Association held its Annual Meeting for 1941 in Oxford, on January 2 and 3, 1942. It was attended by a large number of members and visitors, including a good representation from the United States and from Canada. The meeting was opened by the President, Prof. T. P. McMurray, who later handed over the Chair to his successor in office, Mr. G. R. Girdlestone, of Oxford.

During the business session the following officers were elected:

Vice-President: Mr. R. Ollerenshaw, Manchester.
Hon. Treasurer: Mr. B. H. Burns, London.
Hon. Editorial Secretary: Mr. Norman Capener, Exeter.

The following members of the Executive Committee were chosen:

Mr. W. Gissane, Birmingham.
Mr. F. W. Holdsworth, Sheffield.
Mr. B. L. McFarland, Liverpool.

Additional members were elected to the Executive Committee as a wartime measure:

Prof. Harry Platt, Manchester.
Mr. W. Rowley Bristow, London.
Mr. W. A. Cochrane, Edinburgh.
Prof. T. P. McMurray, Liverpool.
Mr. R. Watson-Jones, Liverpool.

Honorary membership in the Association was conferred upon Dr. Philip D. Wilson, of New York.

The following orthopaedic surgeons were elected to Associate membership: Mr. A. E. Burton, Mr. H. M. Coleman, Mr. E. Mervyn Evans, Mr. M. Meekison, Mr. L. S. Michaelis, Mr. G. Parker, Mr. I. Robertson, Mr. Noel Smith, and Mr. R. J. W. Withers.

The following Associate Members were elected to full membership: Mr. A. L. Eyre-Brooke, Mr. A. J. Watson, Mr. H. L. C. Wood, Lt. Col. Ralph Brooke, and Mr. W. C. Somerville-Large.

At the meeting on Friday, January 2, Prof. T. P. McMurray gave his Presidential Address on *Conservatism in Orthopaedic Surgery*. Remarking on the false impression gained from a study of the programs of the Association during the past ten years, he noted that it would appear that orthopaedic surgeons were mainly concerned with the advance and modification of operative technical procedures. He stressed, however, the larger interest in conservative measures devoted to the correction of deformity and improvement of function through splintage and non-operative methods. When performed, operations in orthopaedics are often only a stage in the restoration of function. Orthopaedic surgeons should not let their minds be deflected from these larger questions of

conservatism, which have become so much wider in the past few years, including re-education and rehabilitation of the crippled and injured. The orthopaedic surgeon must be trained in all the methods by which function can be restored. It was because of the broad outlook of certain surgeons in the matters of diagnosis, prevention, and treatment that the specialty of Orthopaedic Surgery was formed. Failure to maintain the traditional outlook of orthopaedics would only encourage the formation of separate groups, who would concern themselves with special non-operative therapeutic departments.

The following papers were presented:

Arthroplasty of the Hip Joint by Dr. Philip D. Wilson, New York.

A brief review of the history of this operation was given, and a discussion of the two particular methods now employed: (a) fascial interposition, a procedure in use for twenty years, and (b) the use of vitallium cups, during the past three or four years.

Dr. Wilson reviewed his own group of thirty-nine patients, upon whom forty-five arthroplasties had been performed. Of the operations which had been followed up, twelve were by fascial interposition and twenty-eight by the cup method. The best results in both types were obtained where there was solid bony ankylosis, in which the periarticular scarring and adhesion were less than in fibrous ankylosis. The statistics tended to show a slightly better functional result by the method of fascial interposition, but this was somewhat counterbalanced by the simpler technique and easier postoperative recovery in those patients treated by the cup method. Actually, the poor results with the vitallium cup were largely obtained in the group of arthritic patients in whom it was known that the fascial method would have given poor results, but where it was thought important to learn what might be accomplished by the newer method. The best results in the series were obtained in conditions due to trauma or aseptic necrosis. With the vitallium cup there is a wider range of use established in old, unreduced congenital dislocations. There are many technical difficulties, and the greater the surgeon's experience, the better the results.

Some Observations on Paget's Disease by Mr. A. Rocyn Jones, London.

A review was given of the clinical, roentgenographic, histological, and biochemical aspects of this disease, and the help that these studies can give in the diagnosis of osteitis deformans when it affects a single bone.

Fracture in Paget's disease was discussed, with its peculiar transverse character in both complete and incomplete varieties. At a second operation on a patient, made necessary because of the interposition of muscle, some of the callus was removed, and histological study revealed that the healing of the fracture was by normal bone which had none of the characteristic appearance of bone affected by Paget's disease. It is probably because of this fact that fractures in Paget's disease heal so readily.

Recurrent Dislocation of the Shoulder by Mr. A. L. Eyre-Brooke, Bristol.

This paper is based upon the study of a shoulder of a patient who had died following an operation for recurrent dislocation of the shoulder by Nicola's technique. Mr. Eyre-Brooke became interested in the problem because of his experience with this case. He demonstrated specimens of normal shoulders, illustrating the attachment of the anterior capsule to the lip of the glenoid cavity, and then showed in the pathological specimen how this attachment was defective.

In his discussion of the conflicting views of the nature of this lesion, he showed how this case supported Bankhart's view that recurrent dislocation of the shoulder was quite different from the usual anterior dislocation, in that it was caused by direct forward dislocation rendered possible by detachment of the capsule from the anterior rim of the glenoid cavity. Bankhart believed in exposing such a lesion at operation. Those who differ with him rarely expose the region of the lesion.

Bone Grafting of the Fractured Carpal Scaphoid by Mr. J. R. Armstrong.

The "closed" technique for pegging fractures of the scaphoid was described, its difficulties being due to the oblique position of the bone in all anatomical planes. A padded rest in the form of a right-angled groove, each side of which forms an angle of 45 degrees to the vertical, is used on the operating table to support the forearm and hand with the wrist joint in the neutral position. The dorsum rests downward on one side of this groove, so that the forearm and hand are in the position of 45 degrees short of full supination. The long axis of the scaphoid then lies in the vertical plane at an angle of 50 degrees to the anatomically transverse plane of the wrist. A guide pin is inserted in this line distally from the tubercle, and checked roentgenographically. If correct, a special hollow cutting instrument is passed over the guide. Through the hole is passed an autogenous bone graft obtained from the hard subcutaneous border of the tibia.

Twenty-three patients have been operated upon by this method, of whom thirteen have completed treatment, and show bony union. The average period of immobilization was eighteen weeks, the longest being thirty-one weeks and the shortest, eleven weeks. Eight of the patients have wrists which are functionally indistinguishable from normal: two were not seen after removal of plaster; two were returned to full duty, but complained of slight weakness and pain at extremes of movement, which were slightly limited; and one patient, who showed arthritis before operation, was not benefited, although bony union occurred.

Ossification about the Elbow Joint by Mr. Geoffrey Hyman, Leeds.

In this paper a report was given of an investigation upon sixty-seven cases of traumatic ossification about the elbow, which appears most likely to occur following a single severe injury associated with the tearing of ligaments. In almost every case (94 per cent.) tiny, detached flakes of bone were seen soon after injury in the region of the ligamentous attachment, most commonly in those on the collateral and posterior aspects. In the latter, importance was placed on the taking of roentgenograms in the superoinferior plane, with the joint in flexion.

In the cause of this ossification, apart from the bone flakes, predisposing factors were the delayed, repeated, or violent reductions of dislocation, or faulty after-treatment. Collateral ossification does not appear greatly to limit function; the greatest disability occurs when minute areas of ossification are found apparently close to the joint line anteriorly. In the prevention of such ossification, it is important that dislocations be reduced gently and as soon as possible. When established, immobilization upon a posterior plaster splint at an angle of 70 degrees was the treatment.

In one group (fifteen cases), this treatment was continued until the roentgenograms showed disappearance of the new-bone formation, or the process had become stationary,—generally in about twelve weeks. In the second group (twenty-eight cases), the clinical evidences of subsidence were taken,—the absence of swelling and tenderness, and the possibility of full active flexion without pain. With these, the average period of treatment was three weeks, and the results were at least as good as in the first group.

Pelvic Dislocation by Mr. R. G. Taylor, Sheffield.

A review of twenty-two cases of dislocation of the pelvis was reported, the type of case being that in which dislocation of the symphysis pubis of severe degree was accompanied by subluxation at the sacro-iliac joint. At Sheffield Royal Infirmary, out of a total of 13,500 fractures, there were seventy-three fractures of the pelvis and thirteen pelvic dislocations. The generally stated view that such dislocations are produced by direct anteroposterior violence was shown to be incorrect, and that they are in fact due to indirect violence applied to the hindquarter by either hyperextension or hyperabduction of the lower limb on the trunk, the former being the more common. Attempts to join the pubic bones by operative interference were shown to be useless. Two forms of treatment were advised: (1) that described by Watson-Jones, in which the patient is placed in the lateral position upon the sound side so that the dislocated half of the pelvis folds

forward into position, with the reduction maintained in plaster until the pelvic ligaments have healed; or (2) that described originally by Sir Astley Cooper, in which a sling is used, so arranged as to bring the two halves of the pelvis together. In cases in which there was upward dislocation of one hindquarter, previous skeletal traction on the lower extremity was applied until the displacement had been reduced, before applying the pelvic sling.

In the series of cases described, there were three deaths. Of the remaining patients, seventeen were able to walk well within a period of four months, and the other two, who also had fractures of the femur, were walking within five months.

Demonstrations were given as follows:

Bone Grafting of the Carpal Scaphoid and The Treatment of Compound Fractures of the Leg by the Use of Transfixion Pins Fixed to a Thomas Leg Splint by Mr. J. K. McKee, Norwich.

Clinical demonstration at the Wingfield-Morris Orthopaedic Hospital: *Reduction of Congenital Dislocation of the Hip upon an Abduction Frame* by Mr. J. C. Scott, Oxford.

During the Meeting, a statement was made by Mr. W. Rowley Bristow, Hon. Orthopaedic Consultant to His Majesty's Forces at Home. He said that it was in the interest both of the nation and of the individual soldier that the very best treatment be available. More orthopaedic surgeons are required, and he trusts that surgeons of experience will give the matter their serious consideration.

Current Literature

THE 1941 YEAR BOOK OF INDUSTRIAL AND ORTHOPAEDIC SURGERY. Edited by Charles F. Painter, M.D. Chicago, The Year Book Publishers, Inc., 1941. \$3.00.

In the introduction to this volume of the Year Book, the Editor has given an excellent résumé of the development of orthopaedic surgery from the "strap and buckle" stage in the preoperative period, through its escape and migration into the operative status which now equals or rivals that of any of the departments of surgery. It is a question whether it is not the operative lure, rather than the lure of the orthopaedic problem, that brings so much into its net. Too fine distinctions are not desirable, for they provoke division in the specialty itself. It is a question whether it is wise to make a discrimination between orthopaedic and industrial surgery,—the two branches which have so much in common and which are steadily merging. The Editor has wisely treated the conditions resulting from industrial trauma without distinction from those occurring in non-industrial life, and in his discussion of industrial surgery he deals with these conditions with relation to the question of litigation in those cases in which it is a factor. Emphasis is given to the need of pre-employment examination, which has not yet been accorded the position to which it is so evidently entitled.

In presenting the material which has been contributed during this past year, the articles have been put into two groups: Orthopaedic Surgery, and Industrial Surgery and Medicine. In recording the progress and the important contributions in Orthopaedic Surgery during the past year, the Editor has divided the material into thirteen groups, and the discussion of Industrial Surgery is put under five general headings. These divisions facilitate the finding of any special subject on which the reader desires to inform himself.

There are numerous reproductions of illustrations from the original articles, which supplement the text and add to the attractiveness of the volume.

The Editor wisely states that an attempt to record all of the advances which the year of study and investigation has brought forward would not only exceed the limit of the work, but would commit the error of seeming to give authority to undertake procedures which have as yet not passed the test of the end result. This adds value to that which the Editor has chosen, for it gives his endorsement to the subjects which he has selected for this volume.

The Editor quotes from articles and gives his concise and analytical survey of the essentials, and by the grouping of important articles on allied subjects he presents to the reader the present status of the knowledge on each subject in concise form, so that it may serve as a guide to the further study of any special subject.

ARTIFICIAL LIMBS AND THEIR RELATION TO AMPUTATIONS. Ministry of Pensions. London, H. M. Stationery Office, 1939. 3 shillings.

This book has been compiled by the Minister of Pensions from an unusually wide experience in the handling of the great number of amputations resulting from the War. Because the experience was so large and many of the problems were so novel, this department has been a kind of pioneer in the surgery of amputations and in the problem of providing artificial limbs. As a result, a large number of the profession have applied to the Ministry of Pensions for information, both in reference to the surgery of amputation and for advice in regard to artificial limbs. Lectures and demonstrations have been given at the Limb-Fitting Centres, and, because of the requests that they be made more widely available, this handbook has been compiled on the basis of the lecture notes.

Consideration is given, not only to the construction and fitting of the artificial limbs, but also to the more important surgical problems of providing the most practical stumps

at the different levels of the limbs for the best use of prostheses. Methods to be avoided, as well as those to be given preference, are fully discussed; and the definite instructions given will certainly help to solve the whole difficult problem.

The general construction of prostheses and the different mechanical principles of the joints have been fully discussed, as well as the control of movement by the patient and his education in the use of the limb.

The cineplastic amputations are given but a brief discussion, mainly of their history, which is quite sufficient for such a presentation of the subject.

This little book has appeared at a most opportune time and will be of help in many of the problems which will arise in military surgery.

SURGICAL PRACTICE OF THE LAHEY CLINIC, BOSTON, MASSACHUSETTS. Philadelphia, W. B. Saunders Company, 1941. \$10.00.

This book of 897 pages, with 583 illustrations on 376 figures, gives the surgical practice of the Lahey Clinic. Although the many chapters which comprise the book have appeared previously as publications in various journals, taken as a whole, they present a cross section of surgery as practiced at the Clinic in recent years. Each method and technique described is one which in actual experience has proved successful in the hands of one of the members of the Clinic. All procedures have been standardized, with the result that various surgeons may perform each operation in the same way. It is felt that by choosing the procedure which seems best, by constant repetition of it, and by thorough familiarity with it, mortality and morbidity are decreased and end results are improved.

Each chapter of the book covers a region of the body. It opens with a discussion of the region and the conditions to be considered, followed by a comprehensive description of the appropriate operation. The chapter closes with a summary or concluding note, followed by a bibliography. Although all regions are adequately covered, the chapters on the thyroid, abdominal surgery, and anaesthesia are of especial interest. This book, which contains a description of the procedures which have proved their worth at the Lahey Clinic, will prove of value either for quick reference or more prolonged study.

A PRIMER ON THE PREVENTION OF DEFORMITY IN CHILDHOOD. Richard Beverly Raney, B.A., M.D., and Alfred Rives Shands, Jr., B.A., M.D. Elyria, Ohio, National Society for Crippled Children of the United States of America, 1941. \$1.00.

This little book, with numerous illustrations, was written primarily to give a picture of the vastness of the problem of crippling to those not trained in medicine, and secondarily, as an elementary text for those not specially trained in the treatment of crippling deformities. The book is well written in simple non-technical terms. The abundant drawings of the usual deformities and of the methods for their correction are well chosen. The book is divided into divisions to correspond to the various parts of the body.

A book of this type is particularly timely. There has long been a want for this information in simple form. This has been stimulated by the increased interest in physical fitness, and in the prevention of crippling. Dr. Raney and Dr. Shands are to be congratulated in presenting this subject so completely. The book should be of especial value to nurses, physiotherapists, and social workers who assist in the care of children with various crippling deformities.

THE MARCH OF MEDICINE. New York Academy of Medicine Lectures to the Laity, 1941. New York, Columbia University Press, 1941. \$2.00.

Under the title of "The March of Medicine", the New York Academy of Medicine has published the sixth of the series of lectures to the laity given by members of the profession. There is an introduction by Dr. Haven Emerson. These lectures are of very

distinct value in educating the public in the broader principles of medicine and surgery, and tend to bring about a mutual understanding between medical and non-medical groups. The most desirable relation of the lay public to the profession is developed on the basis of a knowledge of the capacity, as well as of the failure, to deal with disease and the control of health. The lectures have wisely avoided the clinical and pathological discussion which so often leads to anxiety and doubt because of limited knowledge, but have emphasized the advances which have added to the security and the health of the community. The importance of the constant recognition of the human side of medicine is evident in these talks, and the choice of subjects shows the effort to instruct the public along general lines, rather than to elaborate on special medical information on the subjects which are selected for these lectures.

The series consists of lectures on "Humanism and Science", "Paracelsus in the Light of Four Hundred Years", "Psychiatry and the Normal Life", "Philosophy as Therapy", "The Promise of Endocrinology", and "What We Do Know About Cancer". Each deals with a matter of special human interest. Although intended for the laity, there is much which will interest and instruct the members of the profession. It is fitting that one of the lecturers selected as his subject Paracelsus, whose influence in developing the rôle of humanism in medicine is recognized.

DIE GOLDBEHANDLUNG DER CHRONISCHEN ARTHRITIS UNTER BESONDERER BERÜCKSICHTIGUNG DER KOMPLIKATIONEN (Gold Therapy in Chronic Arthritis with Particular Reference to Complications). Fredrik Sundelin. Lund, Sweden, Håkan Ohlssons Boktryckeri (*Acta Medica Scandinavica*, Supplementum, CXVII), 1941.

Gold therapy for rheumatoid arthritis has been attracting increasing attention in America during the past five years, and, although this form of treatment has proved distinctly dangerous, a number of outstanding rheumatologists have stated that the results obtainable justify the risks. Gold, therefore, doubtlessly will receive wide clinical trial in this country during the coming years, and Sundelin's splendid monograph certainly will prove of great value to physicians using this form of treatment.

The volume, as its title suggests, deals largely with the toxic complications of gold therapy. It comprises two large sections, the first of which outlines the history of aurotherapy and reviews in considerable detail the literature relating to the toxicity of gold. The second section relates the author's experiences with the untoward effects of this treatment. His observations are based on a careful study of 1095 courses of gold therapy in 730 patients with various forms of chronic arthritis. The work is documented with 814 references and represents the most extensive analysis of the subject ever written. It is a storehouse of information.

Landé and Pick are credited with the first reports on the value of gold in treatment of chronic rheumatism rather than Forestier, who generally receives this honor in American papers.

The records reveal that the incidence of toxic reaction has been less with small doses of gold; on the other hand, serious reactions have occurred even when the doses were minute. In some instances, however, reactions were not observed when the patients were given as much as thirty grams of a gold salt, nearly ten times the usual amount administered at present. It is stated that the therapeutic effectiveness of gold is not dependent upon its bactericidal effect, but appears to rest on some subtle influence exerted on humoral resistance.

Sundelin's summary of the therapeutic claims previously advanced regarding gold therapy in arthritis indicates the basically unsound character of these reports. Lack of uniformity in designating the diseases studied, lack of controls, lack of critical judgment, and a wide variance of claims have distinguished this chapter in the literature of rheumatism therapy,—the same faults which have dogged so many previous episodes. The detailed analysis of previously reported reactions to gold therapy is critical, exhaustive, and interesting.

Introducing the second section, relating to his personal experiences with gold, Sund-

at the different levels of the limbs for the best use of prostheses. Methods to be avoided, as well as those to be given preference, are fully discussed; and the definite instructions given will certainly help to solve the whole difficult problem.

The general construction of prostheses and the different mechanical principles of the joints have been fully discussed, as well as the control of movement by the patient and his education in the use of the limb.

The cineplastic amputations are given but a brief discussion, mainly of their history, which is quite sufficient for such a presentation of the subject.

This little book has appeared at a most opportune time and will be of help in many of the problems which will arise in military surgery.

SURGICAL PRACTICE OF THE LAHEY CLINIC, BOSTON, MASSACHUSETTS. Philadelphia, W. B. Saunders Company, 1941. \$10.00.

This book of 897 pages, with 583 illustrations on 376 figures, gives the surgical practice of the Lahey Clinic. Although the many chapters which comprise the book have appeared previously as publications in various journals, taken as a whole, they present a cross section of surgery as practiced at the Clinic in recent years. Each method and technique described is one which in actual experience has proved successful in the hands of one of the members of the Clinic. All procedures have been standardized, with the result that various surgeons may perform each operation in the same way. It is felt that by choosing the procedure which seems best, by constant repetition of it, and by thorough familiarity with it, mortality and morbidity are decreased and end results are improved.

Each chapter of the book covers a region of the body. It opens with a discussion of the region and the conditions to be considered, followed by a comprehensive description of the appropriate operation. The chapter closes with a summary or concluding note, followed by a bibliography. Although all regions are adequately covered, the chapters on the thyroid, abdominal surgery, and anaesthesia are of especial interest. This book, which contains a description of the procedures which have proved their worth at the Lahey Clinic, will prove of value either for quick reference or more prolonged study.

A PRIMER ON THE PREVENTION OF DEFORMITY IN CHILDHOOD. Richard Beverly Raney, B.A., M.D., and Alfred Rives Shands, Jr., B.A., M.D. Elyria, Ohio, National Society for Crippled Children of the United States of America, 1941. \$1.00.

This little book, with numerous illustrations, was written primarily to give a picture of the vastness of the problem of crippling to those not trained in medicine, and secondarily, as an elementary text for those not specially trained in the treatment of crippling deformities. The book is well written in simple non-technical terms. The abundant drawings of the usual deformities and of the methods for their correction are well chosen. The book is divided into divisions to correspond to the various parts of the body.

A book of this type is particularly timely. There has long been a want for this information in simple form. This has been stimulated by the increased interest in physical fitness, and in the prevention of crippling. Dr. Raney and Dr. Shands are to be congratulated in presenting this subject so completely. The book should be of especial value to nurses, physiotherapists, and social workers who assist in the care of children with various crippling deformities.

THE MARCH OF MEDICINE. New York Academy of Medicine Lectures to the Laity, 1941. New York, Columbia University Press, 1941. \$2.00.

Under the title of "The March of Medicine", the New York Academy of Medicine has published the sixth of the series of lectures to the laity given by members of the profession. There is an introduction by Dr. Haven Emerson. These lectures are of very

They divided the 100 controls into three general body builds, sthenic, asthenic, and normal. The positions of the various portions of the gastro-intestinal tract in the three different body builds were then set up. To illustrate, the position of the lower pole of the stomach in the asthenic was placed at four centimeters below the iliac crest, in the sthenic at the third lumbar vertebra, and in the normal body build at the fifth lumbar vertebra. In similar fashion they postulated the position of the caecum, hepatic flexure, splenic flexure, and sigmoid.

The authors then reviewed 400 roentgenograms of patients with all types and stages of arthritis, with regard to abnormalities in position, structure, and function of the various parts of the gastro-intestinal tract. They found that abnormalities appeared in 60 per cent. of the cases in the gall bladder, stomach, or small intestine. In 80 per cent., there were abnormalities of the colon. Hypotonicity of the colon was present in 40 per cent., and complete atonicity was present in 10 per cent. The authors could not differentiate the atrophic rheumatoid and the hypertrophic osteo-arthritis types by the roentgenographic findings of the gastro-intestinal tract in 100 cases. They admit that there are no destructive aspects of the several features studied characteristic *per se* of arthritis, — for example, pyloric irritability and duodenal spasticity, when present, appear in arthritis precisely as they do when present in cases of gastric or duodenal ulcer, or gall-bladder disease. They state that in the absence of obvious precipitating factors, such as focal infection, it is proper to give greater emphasis to the gastro-intestinal findings. Correction of the gastro-intestinal dysfunction alone cannot be expected to produce good results, unless conducted in conformity with a balanced plan of treatment including systemic rest, equilibrium of the nervous system, optimal nutrition, and the control of infections.—

Victor Wolkins, M.D., Iowa City, Iowa.

CLINICAL INVESTIGATIONS WITH CURARE IN ORGANIC NEUROLOGIC DISORDERS. A. E. Bennett. *American Journal of Medical Sciences*, CCII, 102, 1941.

The author briefly describes the physiological action of curare, and then cites personal experiences with the clinical application of the drug.

He treated twelve cases of cerebral spastic paralysis with injections of ten milligrams of curare per twenty pounds of body weight every other day for a period of three to eight months. Orthopaedic procedures and physiotherapy were carried out at the same time. He concludes that curare produces a definite, but transient relaxing effect upon spasticity without fixed deformity. It reduces incoordination, athetosis, and dysarthria. Favorable progress occurred in the majority of patients while under curare therapy. The treatment is not dangerous, and there are no toxic reactions. Five cases of spastic paraplegia in adults, caused by transverse myelitis and advanced multiple sclerosis, were treated with curare with temporary relaxation of the spastic contractures. The effect is transient, but relief from painful spasm is afforded. The time interval during which relief is experienced is not mentioned. One case of status epilepticus, secondary to a toxic encephalitis, which had failed to respond to various sedative and other anaesthetics over a ten-day period, was treated with curare. The child had had seizures every few minutes. When seen, the child was moribund; but during twelve hours of treatment before death he was completely relaxed.

Six patients with encephalitic, parkinsonism, oculogyric crises, and paralysis agitans were relieved of their tremor and rigidity for one hour, but were unable to carry out active movements.

Four patients with Huntington's chorea were relieved of their incoordinate movements for a few hours. The author states that this is the only drug that has had any effect on the involuntary movements in this disease.

Temporary relaxation lasting one hour occurred in a number of cases of athetosis and dystonia. Temporary results were likewise seen in two cases of tetanus.

The author concludes by stating that although the action of curare is transient, continued experimentation should produce a sustained action. He briefly mentions a syn-

thetic drug, quinine methochloride, which has a curare-like action effective orally. Curare acts at the motor end plate and inhibits the action of acetylcholine on voluntary muscles.—

Victor Wolkin, M.D., Iowa City, Iowa.

VERTEBRA PLANA (CALVÉ). Report of Two Cases. F. Y. Kuhlman. *The American Journal of Roentgenology and Radium Therapy*, XLVI, 203, 1941.

The author briefly summarizes the literature. There were twenty-seven cases reported up to 1938, seventeen being typical of the disease as originally described by Calvé in 1925. Four additional case reports have appeared since. The author describes the typical characteristics of the disease, and presents two cases. He feels the roentgenographic findings are due to aseptic necrosis of the vertebral body, and points out the frequency with which tuberculosis of the spine is confused with this disease entity.

Of interest in the two cases presented is the presence of a history of a slight antecedent trauma and of preceding acute infectious disease. In one case there was no evidence of restitution of normal vertebral contours after eighteen months.—S. M. Albert, M.D., Iowa City, Iowa.

MUSCLE BEHAVIOR FOLLOWING INFANTILE PARALYSIS. Herbert E. Hipps. *The American Journal of Surgery*, LIII, 314, 1941.

The author reports a study of a series of cases of infantile paralysis in which he attempted to determine whether or not a paralyzed muscle tries to recover when placed at rest in a relaxed position. He did not use transplanted muscles in the study or muscles which were hard to demonstrate,—such as the quadratus lumborum. The only patients used were those receiving physiotherapy and brace treatment, or rest and braces. The grading system used was as follows: zero, trace, poor, fair, good, normal.

The results in the three age groups studied were:

- (1) Six months to six years—37.3 per cent. improvement;
- (2) Six years to fifteen years—44.7 per cent. improvement;
- (3) Sixteen years and over—27.3 per cent. improvement.

Two hundred and eighty-seven muscles, graded poor plus, fair, or good, showed much improvement in 87 per cent. of the cases; 276 muscles graded zero, trace, or poor showed slight or no improvement in 90 per cent.

Thus he concludes that muscles which have been paralyzed a long time, and grade only zero to trace or poor, will not benefit by prolonged rest or physiotherapy, while those which grade poor plus, fair, or good can be expected to improve with physiotherapy.

He makes the unanalyzed statement that twenty-five miscellaneous patients who received adequate treatment made an average improvement of 47.5 per cent.; twenty-one patients who received inadequate treatment made an average improvement of 20.6 per cent.

Twenty-three cases were studied to determine the relative efficiency of early treatment, beginning immediately after the temperature subsided, with the following results:

- (1) Early complete rest with splinting—23.8 per cent.
- (2) Early physiotherapy—68.5 per cent.
- (3) No treatment (small number of patients)—31.1 per cent.—T. J. Greteman, M.D., Iowa City, Iowa.

END RESULTS OF SYNOVECTOMY OF THE KNEE JOINT. Ralph K. Ghormley and David M. Cameron. *The American Journal of Surgery*, LIII, 455, 1941.

The authors review Swett's original paper in which were stated the three theoretical considerations on which to base operation for this condition.

1. With foci removed, the inflammatory process in the joints subsiding, and the usual means of absorption of the inflammatory exudate having failed, manual removal of the exudate might promote the resumption of joint function.

2. Such operations might be helpful, not alone by the mechanical improvement, but by removal of organisms capable of continuing the process.

3. Stimulation of metabolism, by prompt restoration of function in atrophic disused joints and muscles, might occur.

The authors state that synovectomy may be employed in a joint in which extensive induration and fibrosis of the capsule, enlargement of the synovial villi, and persistent increase of joint fluid are present. The causes of such conditions may be as follows: chronic atrophic arthritis, traumatic arthritis, benign tumors, osteochondromatosis, syphilitic arthritis, intermittent hydrarthrosis, synovitis ossificans, hypertrophic arthritis, synovial tuberculosis, synovitis caused by a foreign body.

Their results indicate that synovectomy is most useful in traumatic arthritis, synovial osteochondromatosis, and xanthoma or benign tumors. It is of less value, although indicated, in some cases of chronic infectious arthritis. It is of value in chronic synovitis, but the prognosis should be guarded; this holds true also in intermittent hydrarthrosis.—

T. J. Grelman, M.D., Iowa City, Iowa.

COMPRESSION OF CANCELLOUS BONE; Principal Manifestations in Head and Neck of Femur; Treatment by Connecting Drill Channels. Eugene J. Bozsan. *The American Journal of Surgery*, LIII, 537, 1941.

This is a seventy-eight-page supplement to the September issue of *The American Journal of Surgery*, describing the principal manifestations of compression of cancellous bone in the head and neck of the femur. The earlier pages are devoted to a review of the conceptions of hip disease during the eighteenth and nineteenth centuries.

The reason for this article is given in the author's own words. He believes, "all these conditions [osteochondritis dissecans of capital epiphysis, several forms of coxa vara, Perthes' disease, slipping epiphysis, the deforming process in congenital hip, and also the changes in the bones nearby, such as acetabulum, ischium, pubis, etc.] with some others occurring in different parts of the body, and at present not thought related, are based on one single pathogenetic element, and he shall endeavor to evolve a concept of the same which, if given the key position it merits, shall clear the prevailing confusion and shall facilitate the understanding of the grosser features of the whole group."

The author feels he has an explanation for the underlying cause of aseptic necrosis, and a clarification of the relationship of the numerous clinical manifestations. The characteristic wedge-shaped areas of aseptic necrosis may be produced by a mechanism other than infarction,—namely, by compression of a spherically shaped portion of cancellous bone.

Experimentally he has proved the following points:

1. If subjected to compression, a spherically shaped body will suffer damage in an area that is wedge shaped on cross section.

2. In three-dimensional actuality, this area corresponds to a cane with its base at the site of the application of the force.

3. The compression does not damage the whole substance of the cane, but is most effective on the jacket of it.

4. Within the compression pattern, secondary component wedges are demonstrable.

5. Each impact produces its own wedge.

6. The wedge itself is produced by bisecting compression planes inside of which the substance may be damaged.

7. Changes in the curvature of the surface and the speed of force alter the shape of the compression pattern; and, if the change occurs during the insult, a combination of patterns result, and patterns may be superimposed one upon another.

He applies this mechanistic theory to a number of conditions in the head and neck of the femur, which he feels, are all due to areas of trauma to cancellous bone, varying only in location. The same trauma also causes at times subchondral compression of the acetabular bone, resulting in osteochondritis or Perthes' disease.

The relationship of this theory of pathogenesis to causes in arthritis are also dis-

cussed. The author says he has made observations which have convinced him that compression of cancellous bone is the underlying pathological process in this condition.

There are a number of case reports. The article presents an interesting new conception of a single process in the development of many entities.—*T. J. Greteman, M.D., Iowa City, Iowa.*

NEUMOFASCIA DE LA RODILLA (Air Roentgenography of the Knee). Angel Matute V. y Jesus Salas. *Analecta Médica*, I, 9, 1940.

At present lesions of the menisci, cruciate ligaments, suprapatellar pouch, synovial membrane, and fat pads of the knee can be diagnosed only by clinical impressions. The authors have carried out contrast air studies of the knee in over 100 cases.

After nembutal sedation, the needle is inserted into the knee joint along the inter-articular line, and 100 to 300 cubic centimeters of air is injected, care being taken that the needle is not in a blood vessel or that subcutaneous emphysema does not occur. The patient should be kept in bed for twenty-four hours. This technique is contra-indicated with acute infectious or traumatic conditions of the knee.

The following conditions have been demonstrated:

1. Traumatic lesions,—displaced menisci, avulsions of the tendinous fibers with chips of bone, and lesions of the intra-articular ligaments;
2. Arthritic affections,—the separation and destruction of articular cartilages in acute lesions; and ulcerations of the articular ends, loss of joint space, ankyloses, subluxations, osteoporosis, and thickening of periarticular structures in chronic arthritides;
3. Arthroses,—non-infectious articular processes, such as deposition of urate crystals, alkaptonuria, and certain endocrinopathies;
4. Arthromata,—solitary articular chondromata, non-opaque foreign bodies, and malignant soft-tissue tumors;
5. Ankylosis,—the degree and extent of fibrous ankylosis.

The authors feel that the use of the procedure is well warranted in the diagnosis of soft-tissue affections of the knee.—*Victor Richards, M.D., San Francisco, California.*

SEUDOARTROSIS DEL ESCAFOIDES CARPIANO, TRATAMIENTO POR INJERTO ÓSEO (Non-Union of Fractures of the Carpal Scaphoid, Treatment by Means of a Bone Graft). Oscar R. Maróttoli. *Anales de Cirugía*, VII, 31, 1941.

This is a very good presentation of the subject of fractures of the carpal scaphoid in which the literature is reviewed to some extent, and all aspects of the subject are covered. The author believes this fracture is considerably more common than is generally thought, and he feels it is quite frequently overlooked. The peculiar circulation of this bone is described, and to it is attributed the frequent non-union of these fractures. Most of these fractures will heal if immobilized for a sufficiently long time in the proper position, but not all of them will heal. Linear cracks do not seem to be as painful as irregular fractures. Five methods have been used for ununited fractures of the scaphoid: prolonged immobilization, blind drilling, open drilling and curettage of the fracture, bone-grafting, and excision of a fragment or all of the scaphoid. The author discusses each method. A case of his own is presented, an ununited fracture of seven years' duration, in which a bone graft, according to the technique familiar to American orthopaedic surgeons, was used. One interesting minor point is that the hand was draped by placing a sterile rubber glove on it. The author's case was followed for two years, and the patient had an excellent anatomical and functional result.—*Louis W. Breck, M.D., El Paso, Texas.*

CONSIDERACIONES SOBRE EL TRATAMIENTO DE LAS LESIONES DEL APARATO EXTENSOR DE LA RODILLA, BASADA SOBRE HECHOS CLÍNICOS (The Treatment of Lesions of the Extensor Apparatus of the Knee, Clinical Cases). Tadeo Sokolowsky. *Anales de Cirugía*, VII, 63, 1941.

This article is a discussion of the subject of fracture of the patella and rupture of the quadriceps tendon of the knee. The subject is covered as to anatomy, pathology, symp-

toms, and treatment, and is a thorough discussion of the subject. In simple fractures of the patella with separation of the fragments, the author does a careful repair of the tendinous tissue overlying the patella, paying less attention to the knee-cap itself, and being especially careful to repair the aponeurosis on each side of the patella. Only in badly comminuted and in compound comminuted fractures, does he completely remove the patella. Complete rupture of the quadriceps or patellar tendon requires immediate surgical repair. The author lays great stress on early motion in all types of cases, and feels it is of the utmost importance in order to prevent stiffness. He uses a Braun splint for support when motion is begun. For the short time the cast is used, he employs a short light one with the knee in slight flexion, and uses this type of cast even in those cases of fracture without displacement, which were treated non-operatively. Seven cases illustrating various types of lesions are presented.—*Louis W. Breck, M.D., El Paso, Texas.*

RADIOLOGICAL APPEARANCES OF OSTEOARTICULAR LESIONS IN LEPROSY STUDIED THROUGH RADIOLOGY. Mario Soares Da Veiga. *The Antiseptic*, XXXVIII, 579, 1941.

From the X-Ray Institute of Portuguese India, Da Veiga presents an interesting radiological study of the osteo-articular lesions of the hands and feet of 100 lepers. These lesions, which were found in 98 per cent. of the cases examined, are essentially of a destructive character, taking the form of osteoporosis or of osteitis. They are observed generally in patients with cutaneous involvement and with slight changes in the nervous system, and are regarded by the author as a result of local infection through vascular channels. Osteo-articular changes in leprosy of the neurodystrophic type are the result of leprosy involvement of the nervous system, and are revealed under the forms of bone destruction, diffuse osteoporosis, and mutilations, often with symmetrical localization.—

Robert M. Green, Boston, Massachusetts.

ARTRODESE A DELAHAYE NA CURA DA TUBERCULOSE DO JOELHO (Delahaye's Arthrodesis in the Treatment of Tuberculosis of the Knee Joint). Barros Lima. *Arquivos Brasileiros de Cirurgia e Ortopedia*, IX, 75, 1941.

The Delahaye operation is an extra-articular fusion of the knee joint accomplished by a long, flexible, curved, tibial graft, inserted into the anterior surface of the femur, patella, and tibia.

The author has used this method and found that, in spite of a few disadvantages, the method is very useful and should be considered valuable in the treatment of tuberculosis of the knee joint in infants. In view of the danger of growth impairment in intra-articular fusion in children and of other difficulties, the method of Delahaye is preferable. Four cases are presented by the author.—*Emanuel B. Kaplan, M.D., New York, N. Y.*

FRATURAS DA COLUNA DORSO-LOMBAR (Fractures of the Thoracolumbar Spine). Bruno Maia. *Boletim do Instituto de Assistencia Hospitalar*, II, 44, 1941.

The article is based on the experiences of the First-Aid Service of Pernambuco. An analysis and literary review of the subject is presented. The author gives abstracts of eighteen cases of spine fracture, and comes to the following conclusions:

Fractures of the thoracolumbar spine are more frequent than fractures in other regions of the spine.

Roentgenography is the best method of diagnosis.

The most constant subjective symptom is pain in the area of fracture.

The majority of fractures do not show involvement of the nervous system.

Anaesthetic infiltration by the Leriche method in fractures of the spinous and transverse processes, is indicated.

In the treatment of fractures of the bodies of the thoracolumbar vertebrae, the method of Watson-Jones under local anaesthesia, as modified by Böhler, is preferable.

The Watson-Jones reduction of these fractures, with the modification of Kortnetz (hyperextension on a canvas frame), is preferable to the method of Schotte-Zeno (suspension in thoracic hyperextension).

The functional results obtained by the method of Watson-Jones and Böhler are satisfactory.—*Emanuel B. Kaplan, M.D., New York, N. Y.*

HALLUX VALGUS. SURVEY OF END RESULTS OF VARIOUS OPERATIVE PROCEDURES FOR CORRECTION OF HALLUX VALGUS PERFORMED AT THE HOSPITAL DURING THE PAST TEN YEARS (1931-1940). Louis S. Nelson and Emanuel Kaplan. *Bulletin of the Hospital for Joint Diseases*, III, 17, 1942.

For a study of the comparative value of the operative treatment of hallux valgus, seventy-nine patients, who had been operated upon one to ten years before, were re-examined. On these seventy-nine patients, with thirteen unilateral and sixty-six bilateral conditions, 145 operations were performed. These included particularly the procedures described by Silver, Kleinberg, Kellar, Stein, Lapidus, McBride, Peterson, and Levine. The average period of hospitalization was lowest after the Peterson, Silver, and Kellar operations. On an average of three to three and one-half weeks after the Kellar and Silver operations, weight-bearing was possible, but the patient returned to activity more quickly after the Kellar, than after any of the other operations. The percentage of patients satisfied with the postoperative result was greater after the Silver operation than after any other.

The authors feel justified in recommending the Silver operation in mild cases, in patients under twenty years of age. In severe cases the Kellar operation is considered most effective. In patients from twenty to forty years of age, the Stein and McBride operations were effective. In severe cases, the Kleinberg and Lapidus procedures proved satisfactory, although the convalescent period was long. The Kellar operation was recommended, irrespective of age or severity of lesion. In mild cases in patients over forty, provided there was no arthritis, the Silver operation and exostectomy gave good results. In the presence of arthritis, these operations are inadvisable. The Kellar operation appeared to be the operation of choice in the presence of severe deformity and arthritis.—*Henry Milch, M.D., New York, N. Y.*

FRESH COMPOUND FRACTURES. TREATMENT BY SULFONAMIDES AND BY INTERNAL FIXATION IN SELECTED CASES. Willis C. Campbell and Hugh Smith. *The Journal of the American Medical Association*, CXVII, 672, 1941.

The authors' report is based on three years of experience in this method of treatment, and includes a series of fifty private patients treated under optimum surgical conditions, with adequate postoperative care and follow-up, and ninety-three patients of the municipal hospital treated under less favorable conditions. Sulfonamides were used in the entire series; metallic, internal fixation in forty-two of the cases; and primary closure of wounds in the majority. No set routine was followed for all compound fractures, but in general the treatment consisted in adequate débridement, copious irrigation with normal saline, and implantation of five to twenty grams of sulfanilamide crystals in the wound, metallic fixation when indicated—using vitallium stainless steel—followed by primary closure in all cases except those of more than twelve hours' duration, those with soft tissues so extensively mangled that closure of the skin was impossible, or those in which complete débridement was impossible, as in shot-gun wounds of a fleshy part.

In comparing this entire group with a group of seventy-five compound fractures in which neither internal fixation nor the sulfonamides were used, it was found that the percentage of union and non-union, and the average time required for union in the two groups, was approximately the same.

Primary closure, in conjunction with sulfonamide therapy, did not increase the incidence of gas gangrene, nor was there a sufficiently striking decrease in its incidence to in-

dicating a particularly beneficial effect of the sulfonamides on the gas-producing organism. The incidence of infection was reduced from 33.3 to 18.1 per cent.; only two of 143 patients who received sulfonamide died from infection, as compared with three in the control series.

In a comparison of the forty patients in whom internal fixation was used, with the fifty-two in whom no internal fixation was used, it was found that there were fourteen infections and eleven non-unions in the former group, and eleven infections with three non-unions in the latter. There was little difference in the average period required for union between those with and those without internal fixation. The high incidence of infection and non-union in the group with internal fixation, is partially explained by the fact that it was used in those with severe fractures in whom a higher percentage of infection and non-union could be expected. The authors feel that their results have been materially improved by these measures, and do not hesitate to use internal fixation when indicated.—*Brandon Carrell, M.D., Dallas, Texas.*

CONCEALED RUPTURED INTERVERTEBRAL DISKS. A PLEA FOR THE ELIMINATION OF CONTRAST MEDIUMS IN DIAGNOSIS. Walter E. Dandy. *The Journal of the American Medical Association*, CXVII, 821, 1941.

The author makes a plea for elimination of contrast media for localization of ruptured vertebral discs, and presents observations on concealed types of ruptured intervertebral discs which cannot be diagnosed by intraspinal injections.

He avoids spinal injections because they are not necessary; they add to the patient's discomfort; they may mislead; the permanent deposit of iodized oil in the brain and spinal cord is thereby avoided. Diagnosis is based on low mid-line lumbar backache, plus recurring, but not continuous pain down the back of one or both legs, intensified by coughing or sneezing. There may or may not be diminution of the Achilles reflex, or sensory or motor loss in the distribution of the fourth and fifth lumbar, or first sacral nerve. History of trauma may be difficult to elicit, and need not be obtained for diagnosis.

A concealed disc explains many negative explorations. The author has had a series of eight in one month. They were diagnosed only at operation, by careful inspection beneath the dura. The disc, which was softer than normal, was found bound to the emerging spinal nerve by adhesions; and often when the forceps were withdrawn, soft brownish material clung to the instrument. The chances of finding a concealed disc is a further reason for abandoning the procedure of contrast media.—*Clyde B. Trees, M.D., Dallas, Texas.*

ROENTGEN THERAPY FOR RHEUMATOID ARTHRITIS OF THE SPINE (MARIE-STRÜMPPELL ARTHRITIS; SPONDYLITIS RHIZOMÉLIQUE). C. J. Smyth, R. H. Freyberg, and Isadore Lampe. *The Journal of the American Medical Association*, CXVII, 826, 1941.

The authors report the result of roentgen therapy in a series of fifty-two cases of rheumatoid arthritis. Seventy-two per cent. of the patients were benefited subjectively, and 26 per cent. objectively. In some of the cases improvement was on a psychogenic basis. Other patients, however, showed no improvement until the radiation treatment actually was given.

Thirty-two of the patients were checked in regard to sedimentation rate. Forty-one per cent. of this series showed improvement of three-tenths millimeters per minute, or more, in sedimentation rate. In all except one of these, there was clinical improvement. In 9 per cent. an increase in sedimentation rate occurred.

Seventeen patients examined by roentgenography showed no anatomical improvement, and in eight there was actual increase in calcium deposits.

The only potentially serious effect was danger of leukopenia. This occurred only among those receiving the second course of treatment, and in one case the white cell count dropped to 1,100 cells per cubic centimeter. Recovery was complete, however, in a

month's time, and none of the patients showed serious symptoms. Gastro-intestinal symptoms (nausea and vomiting) occurred in some patients four to six hours after treatment, and subsided in two or three days.—*Clyde B. Trees, M.D., Dallas, Texas.*

FRACTURES OF THE SPINE. A STUDY OF TWO HUNDRED CASES. S. Bernard Wortis and Lewis I. Sharp. *The Journal of the American Medical Association*, CXVII, 1585, 1941.

In this article the authors report their study of 200 cases of fracture of the spine in order that a rational routine of treatment might be formulated.

The authors differentiate between complete transverse division of the cord and only partial injury, with the idea that only on the basis of a correct differentiation can proper treatment be instituted.

In the treatment of fractures of the spine they express conservatism and enumerate the procedures and indications which they have found most effective.

The authors suggest that one may remain rather optimistic, even with an apparent severe cord injury, except in cases with flaccid paraplegia and the presence of Gordon-Holmes slow flexion reflex, when the outlook is rather poor.—*Sidney L. Stovall, M.D., Dallas, Texas.*

INJURIES OF THE INTERNAL SEMILUNAR CARTILAGE. POSSIBLE PREDISPOSITION TOWARD; SYMPTOMS AND TREATMENT. Edward K. Cravener and Donald G. MacElroy. *The Journal of the American Medical Association*, CXVII, 1695, 1941.

Following a brief review of the anatomy and the theories concerning the function of the internal semilunar cartilage, the authors describe the different locations of the lacerations in their series. Forty-five per cent. occurred in, or passed through, the avascular portion where healing cannot take place. In only 30 per cent. was there dislocation or disarrangement of structure so as to allow locking of the knee in flexion or extension. Pain was present in 100 per cent., a feeling of instability in 90 per cent., and intermittent swelling in 85 per cent. In 45 per cent. there was pain on rotation of the leg upon the flexed femur, and in 33 per cent. tenderness exactly over the joint line.

In reviewing a large series, the authors found that the injury occurred at an average age of twenty-nine years, and more frequently in overweight, poorly muscled, or sedentary men whose pelvis were broader than normal for their body height.

The authors advocate plaster fixation (following reduction when necessary) for a six weeks' period in all cases of primary injury, since 55 per cent. of the lacerations are in the vascular area and will heal. In the remaining 45 per cent., symptoms will recur, and of this group operative removal will completely cure 72.33 per cent. Failure of operative cure may be due to faulty diagnosis, failure to recognize a concomitant injury of the anterior crucial ligament, failure to remove the major portion or all of the cartilage, injury to the articular cartilage, damage to the internal lateral ligament, persistent synovitis, failure to operate within one year, and regeneration of cartilage.—*Brandon Carrell, M.D., Dallas, Texas.*

UNCOMPLICATED FRACTURES OF RIBS AND MAJOR INJURIES OF THE CHEST WALL, TREATMENT BY INFILTRATION WITH LOCAL ANESTHETIC. Paul H. Harmon, Dan R. Baker, and Robert D. Kornegay. *The Journal of the American Medical Association*, CXVIII, 30, January 3, 1942.

The authors describe a method of treating both minor fractures of the ribs and major injuries of the chest wall by local infiltration with a solution containing 0.5 per cent. procaine hydrochloride and 0.1 per cent. eucupine dihydrochloride, to which epinephrine hydrochloride (10 drops per 100 cubic centimeters) has been added. The advantages claimed for this method are: (1) Pain is immediately abolished; (2) the vital capacity

and the tidal air remain at a more normal level; (3) excessive coughing due to pleural irritation is diminished; (4) the use of general sedatives and cough mixtures is lessened; and (5) the injection is a minor procedure. The only absolute contra-indications are: (1) known hypersensitivity to procaine or epinephrine hydrochloride and sometimes sensitivity to the quinine series of drugs; and (2) a dirty or infected wound in the skin which cannot be blocked off from the field of injection.

In thirty-two cases of minor fractures, one injection was sufficient in twenty-four, two in the remaining eight. The average period of disability until the patient returned to his former work was four and two-tenths days.

This treatment was also used in five cases of severe chest injuries with marked relief of pain and improvement in general condition.—*Brandon Carrell, M.D., Dallas, Texas.*

A METHOD OF TREATMENT OF BURNS AND WOUNDS. John Bunyan. *The Medical Press and Circular*, CCVI, 103, 1941.

The author enumerates the requirements for the proper treatment and healing of burns and wounds, and discusses the three main reasons for failure of proper healing,—namely, chemical, physical, and bacterial irritants.

To satisfy all the requirements for healing and to eliminate the undesirable factors which delay or prevent healing, the author devised an envelope of coated silk which is drawn on over the limb or body. This envelope is transparent, flexible, frictionless, bland to the tissues, excludes secondary infection, and is fitted with two openings through which an irrigating solution may be introduced and drained out simultaneously. The solution which he uses is electrolytic sodium hypochlorite, standardized and stabilized at 1 per cent.

After mechanical or surgical cleansing, the involved area is washed with a solution of electrolytic sodium hypochlorite and dried. The sterilized envelope is applied and strapped to the body with adhesive. Daily thereafter the area is irrigated for twenty minutes by inserting the nozzle of a syringe into the opening of the envelope. The envelope is drained for thirty minutes. Oxygen is run in and the inlets are sealed. This procedure is carried out thrice daily.

The author presents some cases showing the results and the time of healing which illustrate the success of this new method.—*Herbert E. Hipps, M.D., Marlin, Texas.*

THE TREATMENT OF COMPOUND FRACTURES OF THE FEMUR. R. Weeden Butler. *The Medical Press and Circular*, CCVI, 285, 1941.

First aid is best given by immediately fixing the limb in a Thomas splint with moderate traction. If no splint is available, both legs should be fastened together and tied to a long, straight slat, or bar.

At the hospital, the patient is treated for shock, the limb is x-rayed, and antitetanic and anti gas-gangrene sera are given.

The operation is done as soon as possible, with continuous drip transfusion being carried on during the operation. Free excision of damaged muscle and devitalized tissue is carried out, and foreign bodies are removed. Chemical cleansing with antiseptics is not used, but sulfonamide powder is sprinkled into the wound, and sulfonamides are continued by mouth for three or four days after the operation. Unless it is a minor one, the wound is usually packed open with vaseline gauze.

The author discusses the advantages of the plaster spica versus traction with a pin below the knee, and the different dressings used in and on the wound.

For extensive loss of skin, early skin-grafting is advisable. He warns against manipulating a stiff knee after a fractured femur, as the tightness is due to the adhesions between the quadriceps and the femur, and not to intra-articular adhesions.—*Herbert E. Hipps, M.D., Marlin, Texas.*

THE SEQUELÆ TO INJURIES OF THE BONES AND JOINTS. St. J. D. Burton. *The Medical Press and Circular*, CCV, 376, 1941.

Early undesirable sequelae following injuries may be lessened by operative treatment as soon as shock is relieved, by better immobilization, and limitation of the wound dressings.

Wounds involving the shoulder joint may leave some stiffness, but even with complete bony ankylosis there remains little disability if it occurs in the ideal position (60 degrees abduction, 30 degrees external rotation, and elbow forward).

Elbow wounds frequently result in stiffness. If ankylosis is expected, the forearm and arm should form an angle of 120 degrees. The forearm should not be fixed in complete pronation. About half way between this and complete supination is preferable, and leaves a hand which can be used in most trades.

Hand wounds are always serious. Fingers, if ankylosed, should be in slight flexion.

Hip-joint injuries are always serious. Visceral complications, extensive suppuration, and, with healing, traumatic arthritis or ankylosis usually occur.—Herbert E. Hips, M.D., Marlin, Texas.

GOLD INFECTIONS IN THE TREATMENT OF ARTHRITIS. Doris M. Baker. *The Medical Press and Circular*, CCVI, 419, December 3, 1941.

Good results may be obtained with chrysotherapy if the cases are properly selected. The best results are obtained in patients with multiple involvement of an infectious or rheumatoid type of progressive arthritis. Osteo-arthritis, the arthralgias, gouty arthritis, gonorrheal arthritis, and spondylitis do not respond to this treatment.

The stage of the disease is immaterial, and age is of no importance.

Contra-indications are few, but definite. The kidneys must be functioning normally. The liver must be normal, no blood abnormality should be present, and any secondary anacmia must be corrected.

Before beginning treatment, all foci of infection should be eliminated.

The toxic symptoms are presented and discussed.—Herbert E. Hips, M.D., Marlin, Texas.

FRACTURES OF THE FOREARM AND ELBOW IN CHILDREN. AN ANALYSIS OF THREE HUNDRED AND SIXTY-FOUR CONSECUTIVE CASES. Augustus Thorndike, Jr., and Charles L. Dimmler, Jr. *New England Journal of Medicine*, CCXXV, 475, 1941.

The authors present a valuable review of the methods of treating fractures of the forearm and elbow, and indicate that the incidence of such fractures in children under twelve years of age is high. They advise closed manipulative reduction; but if open reduction is necessary for alignment, it should be carried out within forty-eight hours. In their series, the incidence of open reduction was 1 per cent. in fractures of the distal forearm; none in the proximal two thirds; and 6 per cent. in fractures of the elbow. They discuss the well-accepted methods and position of fixation after reduction.

In fractures of the elbow, with the exception of those of the olecranon, the acute flexion position was used, with the position being maintained in the so-called "pistol holster" sling which permits ready inspection of fingers, hand, and radial pulse.

The authors condemn the indiscriminate use of open reduction, and the utilization of bone plates, screws, or other forms of advertised hardware, in treating fractures of the distal third of the forearm.—S. A. Adland, M.D., Iowa City, Iowa.

CALCAREOUS TENDINITIS (PERITENDINITIS CALCAREA) AT THE GREATER TROCHANTER OF THE FEMUR. Louis Kaplan. *Pennsylvania Medical Journal*, XLV, 37, October, 1941.

This condition occurs most commonly at the shoulder, but may occur at other points in the body, such as the supratrochanteric area of the hip, about the insertion of the

flexor carpi ulnaris into the pisiform bone at the wrist, at the ankle, the knee, the elbow, and about the metacarpals and phalanges.

The author reviews the pathology of calcareous deposits, and suggests the term "calcareous tendinitis" as a name which describes the lesion,—since the deposits are in the substance of the tendon, and not around the tendon.

Two cases of "calcareous tendinitis" at the hip are presented, one being bilateral with no symptoms on the right side. The acute symptoms appear to be due to an acute inflammatory reaction about the deposit, with an increase in the tension in the calcified area. Relief of the tension relieves the symptoms, the deposit being then absorbed.

For treatment he uses procaine infiltration of the involved area by which he obtains relief of symptoms with one or two injections of 25 cubic centimeters of 1-per-cent. procaine hydrochloride solution. These patients were seen three and six months later when there was relief of symptoms and dispersion or disappearance of the calcification.—*I. Ponseti, M.D., Iowa City, Iowa.*

TRANSPLANTATION OF FIBULA FOR NONUNION OF TIBIA: REPORT OF CASE. M. S. Henderson and W. H. Bickel. *Proceedings Staff Meetings Mayo Clinic*, XVI, 510, 1941.

The authors report a case of a compound, comminuted fracture of the left tibia and fibula in the upper third, which was treated outside of the Clinic in 1937. In 1940 the roentgenogram of the left leg revealed a non-union of an old comminuted fracture of the upper third of the tibia and fibula, with the loss of about one inch of bone, and that the head of the fibula was united by bony fusion to the superior lateral aspect of the tibia.

An osteotomy of the fibula was done, and it was swung against the tibia after the lateral surface had been freshened. It was held there by a Parham band. Five months later the leg felt solid. It was also stated that the Parham band was to be removed after there was solid union.

If there is non-union of the tibia, and the fibula is intact, there are two methods of choice: (1) an autogenous bone graft, (2) Huntington's operation.

Huntington's operation is the transplantation of the fibula to the tibia in two stages, fusing the upper end first.—*D. L. McCain, M.D., Iowa City, Iowa.*

ARTHRODESE DA TIBIO-TARSICA NA PARALYSIA INFANTIL (Tibiotarsal Arthrodesis in Infantile Paralysis). Paulo Zander. *Revista Brasileira de Orthopedia e Traumatologia*, II, 107, 1940.

In certain cases of completely flail ankle joint, a fusion of the joint results in a very satisfactory foot. The author uses a modified technique. The astragalus is removed and denuded of its cartilaginous surfaces, the cartilage is also removed from the tibia and the scaphoid. A few vertical, deep, saw cuts are made into the articular surface of the tibia and the astragalus and, if necessary, in the other small bones of the tarsus; the astragalus is replaced and the ankle is fixed in slight equinus. In the four patients operated upon, the author was impressed by the very firm fusion of the bones which occurred within a few weeks, and ventures the opinion that it may even be possible to accomplish a fusion of the ankle joint by deep cuts into the articular surfaces without removal of the cartilage of the joint.—*Emanuel B. Kaplan, M.D., New York, N. Y.*

THREE PATIENTS SHOWING THE RESULT OF TREATMENT OF CARPAL DISLOCATION. F. A. Simmonds. *Proceedings of the Royal Society of Medicine*, XXXIV, 507 (Section of Orthopaedics p. 11), 1941.

The author presents three cases of anterior dislocation of the carpus, following hyperextension injury to the wrist, all three of which failed to respond to manual reduction. Symptomatology was characterized by swollen wrist, immobile fingers, and

evidence of "median nerve irritation". The first case responded to skeletal traction by means of Kirschner wires through the metacarpal bases and the olecranon, and the use of the Zimmer apparatus. The dislocation was reduced by manipulation while the traction was active.

The other two cases failed to respond to this skeletal distraction method, and open reduction was necessary.

The author is also of the opinion that excision of the lunate alone gives a good result, but that removal of the scaphoid results invariably in a very poor wrist. He, therefore, feels that when excision of the scaphoid becomes necessary, the entire proximal carpal row should be removed. The latter procedure offers a prospect of a fair end result.—*S. M. Albert, M.D., Iowa City, Iowa.*

DA RADIOTERAPIA NA PERI-ARTHRITE ESCAPULO-HUMERAL (X-RAY THERAPY IN SCAPULO-HUMERAL PERIARTHRITIS). Achilles de Araujo e Carlos Osborne. *Revista Brasileira de Orthopedia e Traumatologia*, II, 235, 1941.

The authors report a series of fourteen cases of periarticular arthritis and bursitis in which deep roentgen-ray treatment was carried out. Direct irradiation, with 100 to 120 roentgen units given twice weekly over the affected area, was used.

After the first treatment the pain diminished considerably, and sometimes after the second or third ceased completely. The opaque shadows in the subdeltoid areas showed a tendency to decrease in size, or completely disappear. The clinical improvement was rapid and effective in thirteen cases of this series.—*Emanuel B. Kaplan, M.D., New York, N. Y.*

UM NOVO TIPO DE PLACA PARA OSTEOSINTESE (A New Type of Plate for Bone Fixation).

Octavio Caputti. *Revista Brasileira de Orthopedia e Traumatologia*, II, 274, 1941.

A new metal fixation plate is described, consisting of a horizontal plate with a vertical piece arising from the undersurface of the horizontal part, forming a sort of T. A slot is made in the proximal and distal fragments of the bones which are to be fixed, the vertical part is introduced into the slot, and the horizontal plate is fixed with screws to the cortex of the bone. In this fashion the lateral, as well as the anteroposterior, displacement of the bone is prevented.

The author believes this plate has an advantage over the Hawley plate (*The Journal of Bone and Joint Surgery*, XX, 469, April 1938)—made in the form of an L, and based, perhaps, on the same principles—because of the greater ease of its removal.—*Emanuel B. Kaplan, M.D., New York, N. Y.*

LUXACION HACIA ADELANTE DE LA EXTREMIDAD INFERIOR DEL CUBITO. SECUELA DE FRACTURA DEL TERCIO INFERIOR DEL RADIO (Forward Dislocation of the Distal End of the Ulna Following Fractures of the Distal Third of the Radius). Herbert Cagnoli. *Revista Brasileira de Ortopedia e Traumatologia*, II, 365, 1941.

The author calls attention to the comparative frequency of the indirect forward dislocation of the distal end of the ulna, which develops slowly, following malunited fractures of the distal third of the radius. In these fractures, an anterior angulation of the radius produces a disorganization of the distal radio-ulnar joint, with a distention of the anterior ligament of this joint. The articular surface of the radius remains in contact with the carpal bones, but the ulna luxates forward. The author describes three cases of varying gravity. In an early and mild case, an osteotomy of the radius to correct the deformity was sufficient. In a more severe case a reconstruction of the anterior ligament of the distal radio-ulnar joint with a periosteal graft from the tibia was added to the osteotomy of the radius. In a very severe case, in addition to the corrective osteotomy of the angulation of the radius, the dislocated end of the ulna was completely removed.—*Emanuel B. Kaplan, M.D., New York, N. Y.*

ANÁLISIS EXPERIMENTAL DE LAS SOMBRAS EN LA NEUMOARTORRADIOGRAFIA DE LA RODILLA NORMAL (Experimental Analysis of the Shadows in the Pneumoroentgenography of the Normal Knee). Enrique H. Lagomarsino y Hector Dal Lago. *Revista de Ortopedia y Traumatología*, X, 393, 1941.

As a result of personal experience with arthroscopy and pneumoroentgenography applied to the knee joint, the authors have rejected arthroscopy because of its doubtful results and because it implies opening the joint. They believe an exploratory arthrotomy would give better results. The introduction of liquid contrast media into the joint has always produced articular reactions. Their latest practice has been to inject air into the joint until there is enough tension to give an elastic sensation, but not enough to cause a sharp pain, as pain is considered to be due to an injury of the articular structures.

Interpretations of the roentgenographic shadows of a normal knee joint differ according to the various schools of thought, with consequent different interpretations of the pathology. The authors have undertaken studies of roentgenograms of normal knee joints and have analyzed the results. They made roentgenograms of knees in which the cruciate ligaments and menisci had been resected, and found that the shadows of the articular cartilage of the femur and tibia were not of a uniform thickness of three millimeters, but were thicker at the middle portion of the femoral condyle and gradually became thinner toward the intercondylar notch. Other roentgenograms were made of knees from which a part or the whole of the cartilage had been removed, or in which the cruciate ligaments had been resected, and their shadows were compared with those on roentgenograms of normal knee joints with all the structures intact.

The article is profusely illustrated. The authors believe they have demonstrated that there is a disparity between the usual interpretation of a roentgenogram of a normal knee joint and their findings.—*Leon Avila, Jr., M.D., San Salvador, El Salvador.*

LUXACIÓN ACROMIOCLAVICULAR. DISPOSITIVO PARA SU TRATAMIENTO Y TRABAJO EXPERIMENTAL (Acromioclavicular Dislocation. A Method of Treatment and Experimental Work). Domingo Muscolo. *Revista de Ortopedia y Traumatología*, XI, 69, 1941.

Due to the disposition of the articular surfaces of the acromioclavicular joint, the clavicle has a tendency to slide over the acromion, when pressure is applied on the shoulder in a downward and medial direction. At first the ligaments stretch; then, if the force continues, they tear.

According to general opinion, the isolated rupture of the acromioclavicular ligaments produces only a certain degree of subluxation of the clavicle, and the rupture of the coracoclavicular ligaments is indispensable in producing a complete dislocation.

In order to verify these facts the author experimented on a cadaver by cutting the coracoclavicular ligaments. Roentgenograms taken while the arm was pulled strongly downward showed only a slight subluxation of the clavicle. In the opposite shoulder the capsule and the acromioclavicular ligaments were cut, the coracoclavicular ligaments being left undisturbed. This time the roentgenograms showed a complete dislocation of the clavicle.

In order to treat such a dislocation, the author applies a shoulder spica which extends down to the hips and includes the upper two thirds of the arm. A window is cut over the acromioclavicular joint, and a U-shaped iron bar is included in the cast over the shoulder. This bar holds a screw device in the middle to apply pressure over the clavicle. The pressure should be increased a little every day, so as to obtain reduction on the third day. A quick reduction is not desirable because the skin may slough. Two cases have been treated in this way with good results.—*Leon Avila, Jr., M.D., San Salvador, El Salvador.*

TREATMENT OF FRACTURES OF THE LOWER THIRD OF THE HUMERUS. F. Adelbert Hoshall. *Southern Medical Journal*, XXXIV, 1152, 1941.

The narrator is convinced that skeletal traction with a shoulder spica is the method of choice in these cases. He is equally convinced that when there is a displaced fragment of either the medial or lateral condyle or epicondyle, open reduction is required, with wiring, pinning, or suturing of the displaced fragment, and holding the arm in a cast in the position of greatest immobility. Open operation was done in fifteen of 204 cases. A detailed description of the various fractures involving the condyles is included.—

Fred G. Hodgson, M.D., Atlanta, Georgia.

FRACTURES OF THE HIP. THE PRESENT STATUS OF ITS TREATMENT. R. T. Hudson. *Southern Medical Journal*, XXXIV, 1154, 1941.

This includes both intracapsular and extracapsular fractures. Internal fixation under roentgenographic control is advocated. The author prefers to use four Moore pins for both the intracapsular and the intertrochanteric fractures. No type of external fixation is needed in the after-care.

He also recommends Murray's subtrochanteric osteotomy for cases of non-union of fracture of the hip.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

HISTORICAL REVIEW OF METALS USED IN ORTHOPEDIC SURGERY. F. Walter Caruthers. *Southern Medical Journal*, XXXIV, 1223, 1941.

This is a historical review of the metals used in the fixation of bones from Fabricius to the present day. Malgaigne in 1840 used his metal clamp for fractures of the patella. Lambotte used metal plates and screws in 1902. Rugh experimented with sixteen different types of metal. Lane in 1905 did much to popularize the use of metal plates and screws. John B. Murphy also advocated nails, screws, and wires. Many other surgeons are mentioned who have used various types of metals. Vitallium is one of the most popular and highly recommended of modern metals. The last author mentioned is Key who has recommended the stainless steel 18-8 SMO.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

THE USE OF SULFONAMIDES IN CLEAN OPERATIVE WOUNDS. J. Albert Key. *Southern Medical Journal*, XXXV, 55, January 1942.

In spite of the advance in operating-room technique, a certain number of clean wounds become infected in even the best hospitals. Many new methods are being studied to reduce still further the number of these infections. Key, having determined that small amounts of sulfanilamide powder placed in the wounds did not delay healing, has been using this powder routinely in all clean operative wounds for the past two and one-half years. He presents a series of 150 cases with no postoperative infections. During the past year he has been using sulfathiazole from sterile ampules. Sometimes he combines the two drugs. In no case has there been any systemic reaction to the drug. Its use should not allow any relaxation in the most rigid aseptic technique.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

SLIPPING OF THE UPPER FEMORAL EPIPHYSIS. M. Beckett Howorth. *Surgery, Gynecology and Obstetrics*, LXXIII, 723, 1941.

The author reports on forty cases, the end-result standard being a painless hip, free of limp, and with full motion and full capacity for normal activity.

In the preslipping stage, it is desirable to prevent weight-bearing, and not to apply a cast because of the atrophy of disuse. One-half inch or more of slipping should be

present before reduction is attempted. Reduction of less than one-half inch of slipping was attempted in twenty-one cases with only three successful results. Heavy traction has been tried by the author with good results.

Eleven open reductions were performed; six were osteotomies and gave only fair results. From 1930 to 1939, seventeen patients were treated by open reduction through the epiphyseal disc; eleven were immobilized in plaster for from ten to twelve weeks, and were followed for periods of two and one-half to seven years. Only two good results were obtained. In six patients internal fixation was used; the results two and one-half years later were excellent in two cases, fair in three, and poor in one.

The drilling operation was used in forty cases, so far with good results in thirty-five, although it is still too early for a complete end-result analysis.

Subtrochanteric osteotomy for deformity is advocated.—*F. E. Thornton, M.D., Iowa City, Iowa.*

SYNOVIAL SARCOMAS IN JOINTS, BURSÆ, AND TENDON SHEATHS. A CLINICAL AND PATHOLOGICAL STUDY OF SIXTEEN CASES. Dominic A. De Santo, Robert Tennant, and Paul D. Rosahn. *Surgery, Gynecology and Obstetrics*, LXXII, 951, 1941.

The authors report on a study of sixteen cases of synovial sarcoma. These usually originate in synovial tissue, and thus are found in joints, para-articular bursae, and tendon sheaths. These tumors usually fall into three types: (1) encapsulated, (2) circumscribed, (3) diffuse. From their own cases and some from the literature, the authors found the order of frequency of joint involvement to be: knee, elbow, forearm, thigh, shoulder, finger, and foot. The etiology is considered to be trauma and the influence of a chronic bursitis or synovitis. Symptoms are usually pain, tumor, joint dysfunction, and occasionally swelling. Roentgenographic examination gives positive evidence late in the disease; and symptoms are usually likewise late. Ten of the thirteen patients x-rayed showed a soft-part tumor near the joint. In two cases bone destruction was the only visible finding.

Treatment is quite radical, early amputation being of the greatest value. Excision only leads to early recurrence. The value of roentgen therapy has not as yet been established.

These tumors usually appear as undifferentiated fibroblastic tumors, generally indistinguishable from fibrosarcoma or spindle-cell sarcoma, unless synovial clefts or small areas of reticulo-endothelial evolution are located. In general, slow growth and late metastasis are the rule.—*F. E. Thornton, M.D., Iowa City, Iowa.*

DIAGNOSIS OF SCIATICA AND LOW BACK PAIN DUE TO HERNIATION OF INTERVERTEBRAL DISKS. G. E. Haggart. *Surgical Clinics of North America*, XXI, 889, 1941.

The author states that 3 per cent. of all patients who come to the Clinic for relief of low-back pain are found to have a protrusion of the intervertebral disc. Oxygen in the subarachnoid space is used exclusively at Lahey Clinic to demonstrate the defect in the roentgenogram. The history is characteristic and well known. He states that sensory changes are found almost exclusively in those patients with large disc protrusions, in whom there is muscle-wasting in the gluteal region as well as fibrillary twitchings of muscles either in this area or throughout the lower extremity on the involved side. Determination of the total protein content of the spinal fluid is important, and, if elevated, is evidence in favor of subarachnoid irritation. The author finds that, in those patients engaged in laborious work, and particularly in the individuals who exhibit an unstable lumbosacral articulation, fusion of this joint done at the same time as the laminectomy has given a better end result than has laminectomy alone.—*J. E. Fuchs, M.D., Iowa City, Iowa.*

COMPRESSION FRACTURES OF THE DORSOLUMBAR VERTEBRAE. John W. Gullikson and Edward R. Anderson. *Western Journal of Surgery, Obstetrics and Gynecology*, XLIX, 576, 1941.

The authors stress the importance of the "Soto-Hall" sign. This test is performed by acute flexion of the neck, and causes pain at the fracture site due to stretching of the ligamentous attachments of the vertebrae. By this test many fractures likely to be missed can be discovered.

In the treatment advocated, the patient is placed in bed and a sling is placed about him at the fracture site with a pulley arrangement and about forty to fifty pounds of overhead traction. This produces gradual hyperextension which the authors believe superior to rapid forceful methods, especially in patients with other injuries. The patient is allowed to rest in this apparatus for from four to ten days, and is then placed in a Rogers hammock frame in hyperextension. A body cast is then applied in this position, care being taken that a tight fit is secured about the pelvis. A window is cut in the abdomen to facilitate breathing. The patient is allowed up and about with the cast after two or three days. This is worn for at least two or three months, and is followed by a Taylor spinal brace for another two months, after which physiotherapy and graded exercises are started. The usual patient is able to discard his brace in from six to eight months, and is able to return to his usual work at that time.

Thirty-four cases of compression fracture were treated by this method. The average length of disability was eight and two-tenths months. There was one operation for compression symptoms of the cord to which the patient responded successfully. No development of Kümmell's disease was seen in this series. Thirty-two patients were able to return to their regular work; twelve had occasional backaches, though not severe enough to cause loss of time; and sixteen were symptom-free.—*F. Harold Downing, M.D., Fresno, California.*

COMPOUND FRACTURES. Carleton Mathewson, Jr. *Western Journal of Surgery, Obstetrics and Gynecology*, XLIX, 628, 1941.

The author reviews the principles gained from his experience in treating over 500 cases of compound fractures within the past ten years. He regards a compound fracture as an urgent emergency, and believes that, if infection is to be avoided, débridement must not be delayed, and every effort must be made to thoroughly cleanse the wound. Accurate immobilization is essential. Infected wounds, and wounds that cannot be closed without tension, should be left open and packed with vaseline gauze. Infrequent dressings are advised. Primary closure is justified when the local conditions warrant its use.

Prophylaxis against tetanus and gas infection was always given and, in addition, small doses of roentgen therapy were given locally to the wounds, through the cast, immediately and on the following two days. What effect this has had upon the development of gas infections, the author is not prepared to say.—*F. Harold Downing, M.D., Fresno, California.*

RHEUMATISMUS, ENDOKARDITIS UND TUBERKULOSE IM KINDESALTER (Rheumatic Fever, Endocarditis, and Tuberculosis in Childhood). E. Glanzmann. *Zeitschrift für Rheumaforschung*, IV, 169, 1941.

The author reports the occurrence of three examples of tuberculous infection, with joint swelling, pain, and endocarditis. The tuberculous infection was in the lungs or lymph nodes. The condition greatly resembled a rheumatic fever. In all of the cases the endocarditis subsided. There seemed to be less probability that two infections were present than that the entire symptomatology was due to tuberculosis. Arthritis in the sense of acute polyarthritis is very rarely a sequel to tuberculosis. Umber found only three cases of polyarthritis in 700 cases of tuberculosis, and Edström found eleven cases of polyarthritis in 694 cases of tuberculosis.—*John G. Kuhns, M.D., Boston, Massachusetts.*

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The Journal of Bone and Joint Surgery

"EOSINOPHILIC OR SOLITARY GRANULOMA" OF BONE *

BY WILLIAM T. GREEN, M.D., AND SIDNEY FARBER, M.D.
(WITH THE ASSISTANCE OF LEO J. McDERMOTT, M.D.),
BOSTON, MASSACHUSETTS

*From the Departments of Orthopaedic Surgery and Pathology,
The Children's Hospital and the Harvard Medical School, Boston*

Since 1930 the authors have had the opportunity to study thirteen children who suffered from a disease process characterized by either solitary or multiple destructive lesions of bone, without clinical or roentgenographic evidence of visceral disease. These lesions appeared to be identical with what has been described, in the recent literature, as a new disease under the name "solitary granuloma" ⁶ and "eosinophilic granuloma" ⁵. On the basis of pathological studies of material which included tissue removed at operation from patients to be discussed in this paper, Farber concluded that these benign destructive lesions of bone do not constitute a new disease, but represent rather one variant of a basic disease process, of which the clinical pictures known as Hand-Schüller-Christian disease, certain forms of xanthoma, and Letterer-Siwe disease are other examples.

Ten of the patients observed have been followed for a sufficiently long period to be included in a detailed analysis. Material was removed at biopsy in every case. Nine of these children have been examined recently. With one exception, all of the patients have been under observation throughout the clinical course of the disease. It is the purpose of this report to describe the important clinical findings in this group of patients, and to discuss briefly the pathological picture. A discussion of the nature of the disease process, with a presentation of the pertinent data, will appear elsewhere.

* Read at the Annual Meeting of The American Academy of Orthopaedic Surgeons, Atlantic City, New Jersey, January 13, 1942.

CASE REPORTS

CASE 1. C. D. (163932), male, aged two years. Multiple bone lesions. Minimal systemic manifestations. Two biopsies. Repeated roentgenotherapy. Follow-up after eight years: clinically well; no residua other than the healed defect of one vertebra.

This patient was first seen at The Children's Hospital on August 18, 1932, with a complaint of a limp and pain in the right leg of two weeks' duration. Both the familial and personal history were otherwise completely negative. There was no known injury preceding the onset of symptoms.

The patient was a well developed and nourished child, whose significant physical findings were limited to tenderness and questionable thickening over the upper end of the right fibula, with palpable crepitus. His temperature was normal. Examination of the urine revealed no abnormal findings, nor did microscopic examination of the blood, except for a leukocytosis of 17,000. The intradermal injection of tuberculin gave no reaction, and the Hinton test for syphilis was negative.

Roentgenograms taken at this time showed an area of destruction, involving two centimeters of the upper end of the fibula, and a pathological fracture through the eroded area, without displacement (Fig. 1-A). There was a little new bone at the distal end of the area, but none in the immediate lesion. The roentgenographic and clinical impres-

sion at this time was that of an osteomyelitis with a pathological fracture, although other possibilities were considered.

On August 22, the area was explored. A brownish-gray tissue occupying the site of the lesion was excised. There was no evidence of pus, and culture did not show any bacterial growth. The wound healed *per primam* and the postoperative convalescence seemed uneventful.

Three months after the original admission to the Hospital, the patient fell and complained of pain in his right arm near the shoulder. Examination showed tenderness in this area, although he seemed to be otherwise well. Roentgenograms taken at this time showed a new lesion in

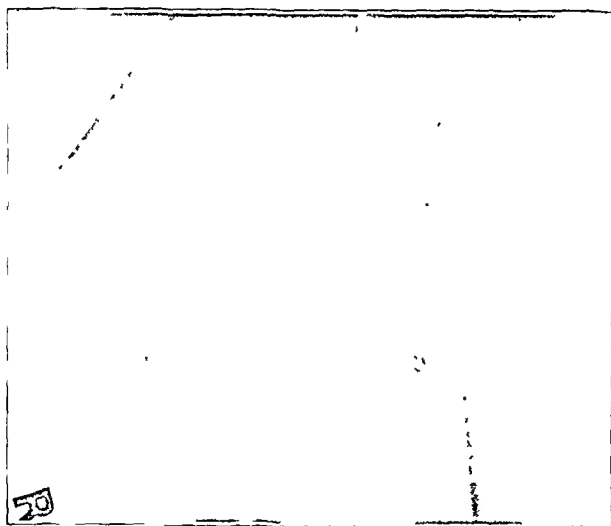


FIG. 1-A

Case 1. C. D. August 19, 1932. Roentgenograms show destructive lesion of the right fibula with a pathological fracture.

the shaft of the humerus some distance from the upper epiphysis, of a type similar to that seen in the fibula (Fig. 1-C). The fibula at this time showed evidence of considerable healing. Roentgenograms were taken of the rest of the skeleton, which showed many lesions in the skull, ribs, humeri, pelvis, and femora (Fig. 1-E). The boy seemed to be perfectly healthy with no symptoms other than the disability in his arm.

Laboratory studies at this time were not remarkable. On repeated examinations he still had a leukocytosis of from 15,000 to 18,000, with a normal differential count. The blood levels of calcium, phosphorus, non-protein nitrogen, and cholesterol were entirely normal, as were the serum protein, and the albumin-globulin ratio. Tests to evaluate kidney function did not demonstrate any abnormality, and Bence-Jones protein was not found in the urine on repeated examinations. The possibilities of neuroblastoma, hypernephroma, and Hand-Schüller-Christian syndrome were considered in the roentgenographic interpretation of the bones.

A biopsy of the left eighth rib was made at this time. Roentgenotherapy of the various bone lesions of the skull and the upper end of the humerus was begun on December 22, 1932; and of the pelvis, upper femora, and ribs on January 9, 10, and 11, 1933. Roentgenograms on February 12, 1933, showed the original lesions of the skull, humerus, ribs, and pelvis to be greatly improved. This was less than two months after the initial treatment to the skull and humerus, and indicates the rapidity with which healing may occur in this disease. Further treatment was given at this time to the skull in the areas involved, and to the humerus. On March 13, 1933, multiple new lesions had appeared in other areas of the skull, which were not visible in the roentgenograms one month previously. This, in turn, illustrates the rapidity with which destruction of

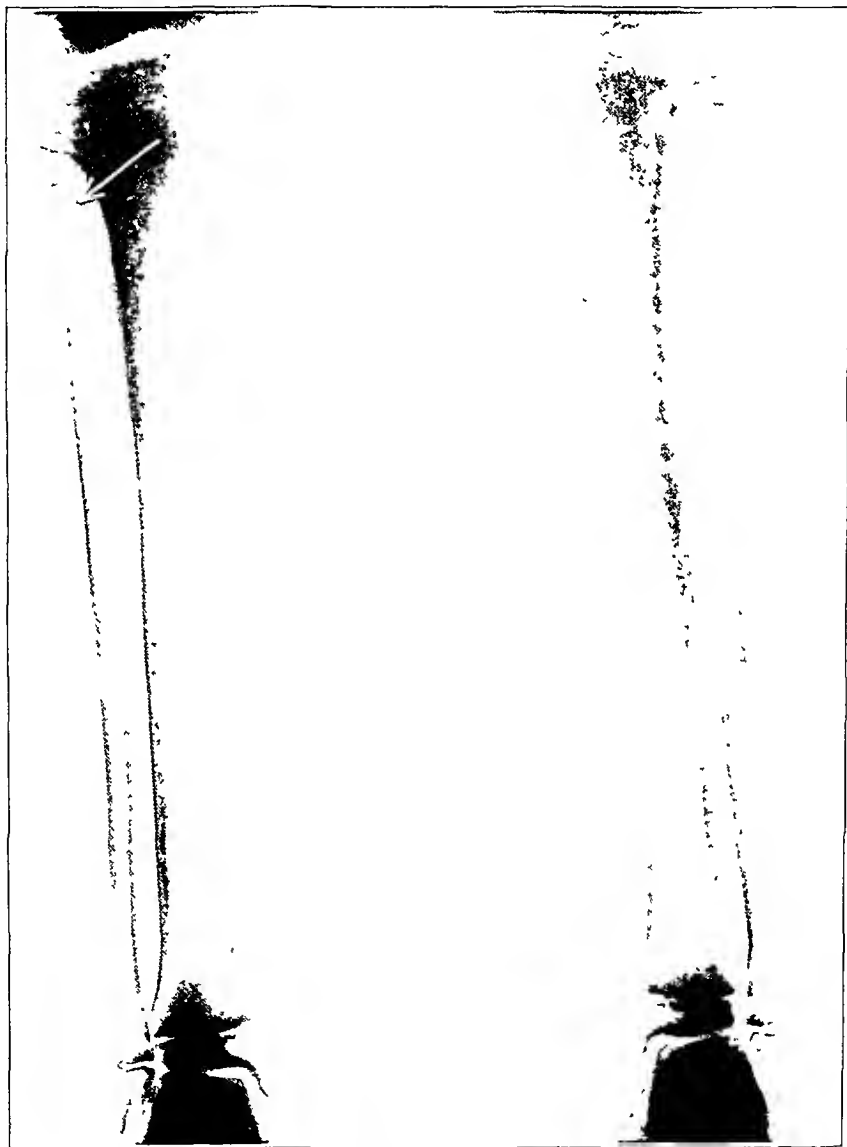


FIG. 1-B

Case 1. C. D. December 9, 1940. Follow-up roentgenogram eight years later shows the lesion to be completely healed. Compare the right fibula with the left.

bone may occur in the process. Throughout the course, the disease was characterized by the susceptibility of the lesions to roentgenotherapy and their rapid healing, and by the simultaneous development of new lesions in other areas. No new lesions were noted after August of 1933 (Fig. 1-G). The last roentgen treatment was in November 1933, which was fifteen months after the patient's original admission. In all, he had eleven sessions of therapy, with a dosage of from 400 to 800 roentgen units. Single fields, or two fields in the same area on successive days, were utilized. Roentgen exam-

inations of June 1934, 1935, 1936, 1939, and 1940 showed no residua of the previous disease, except for a residual collapse of the ninth thoracic vertebra (Fig. 1-I). Clinical examination in 1940, eight years after the onset, showed normal findings. Throughout the course, the boy showed no evidence of systemic disturbances.

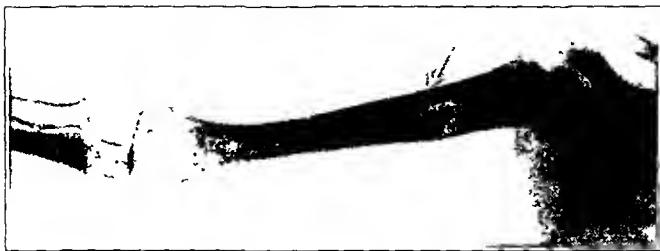


FIG. 1-C

Case 1. C. D. November 30, 1932. Roentgenogram shows the area of destruction in the right humerus as seen in the first roentgenogram of this area.



FIG. 1-D

Case 1. C. D. December 9, 1940. Follow-up examination shows that no trace of the lesion remains.

Tissue removed from the fibula at the first operation in 1932 revealed a process in which eosinophiles were so numerous in areas that they colored the field red with their cytoplasmic granules (Fig. 1-J). A considerable amount of fibrous-tissue repair of the process was evident. Many of the cells in the involved area were myelocytes. Plasma cells and occasional foci of polymorphonuclear leukocytes were also present.

Examination of material removed from the rib at the second operation revealed a type of tissue which was at first interpreted to be neoplastic. In the hematoxylin and eosin stains, the cytoplasm of large tumorlike cells was blue-gray in color, finely granular, and, in many instances, vacuolated. The nuclei were round to horseshoe-shaped. Large numbers of eosinophilic myelocytes and mature eosinophiles, and numerous lymphocytes were also present.

Interpretation of the lesions in 1932 was difficult because of the large number of cells of the myelocytic series, and a diagnosis of myelocytic myeloma, atypical, was made. Examination of tissue removed from other patients with a similar clinical problem, and consideration of the course of the disease process subsequent to the first biopsy led to reclassification of the process as a granuloma of the type under discussion in this paper.

CASE 2. R. B. (232051), male, aged four years and seven months. Single lesion of ilium. Biopsy. One series of roentgenotherapy, 1500 roentgen units. Follow-up over two and one-half years after onset: clinically well; no residua.



FIG. 1-E

Case 1. C. D. December 3, 1932. Many areas of destruction are present in the pelvis, as well as a lesion in the neck of the left femur.



FIG. 1-F

Case 1. C. D. March 1, 1935. No evidence of the lesions remains.



FIG. 1-H

Case 1. C. D. March 1, 1935. The lesions are no longer evident.



FIG. 1-G

Case 1. C. D. August 21, 1933. Multiple lesions of the skull are seen.

This boy was admitted to The Children's Hospital on May 16, 1938, with a complaint of limp and pain in the right hip of three weeks' duration, associated with a poor appetite. On examination, he was a well-developed and nourished boy who did not appear ill. He walked with a limp, and there was slight protective muscle spasm of the hip, as well as slight tenderness on the right side of the pelvis by rectal examination. There were no other positive findings.

Roentgen examination at this time showed a large area of destruction involving the ilium adjacent to the acetabulum (Fig. 2-A). No other lesions in the skeleton were demonstrable.

Laboratory studies gave essentially normal values. He did have a white-blood-cell count of 10,700, with a not unusual differential count. Blood calcium, phosphorus, phosphatase, cholesterol, blood fat, and total protein were all within normal limits. There was no Bence-Jones body in the urine.

Exploration of the lesion was carried out on May 25, 1938. The area of bone destruction was filled with a dark reddish-gray, gelatinous tissue which was moderately vascular, and was easily curetted from the bone. Histopathological examination revealed a process identical with that found in Case 1. The patient was given one series



FIG. 1-I

Case 1. C. D. July 21, 1939. The only visible residuum of many bone lesions is deformity of the ninth thoracic vertebra, which has remained unchanged for four years. The many ribs previously involved show no evidence of the disease.

of x-ray radiation from June 8 to June 14, with daily exposure of 250 roentgen units, using two different fields. The total amount given was 1500 roentgen units. The boy

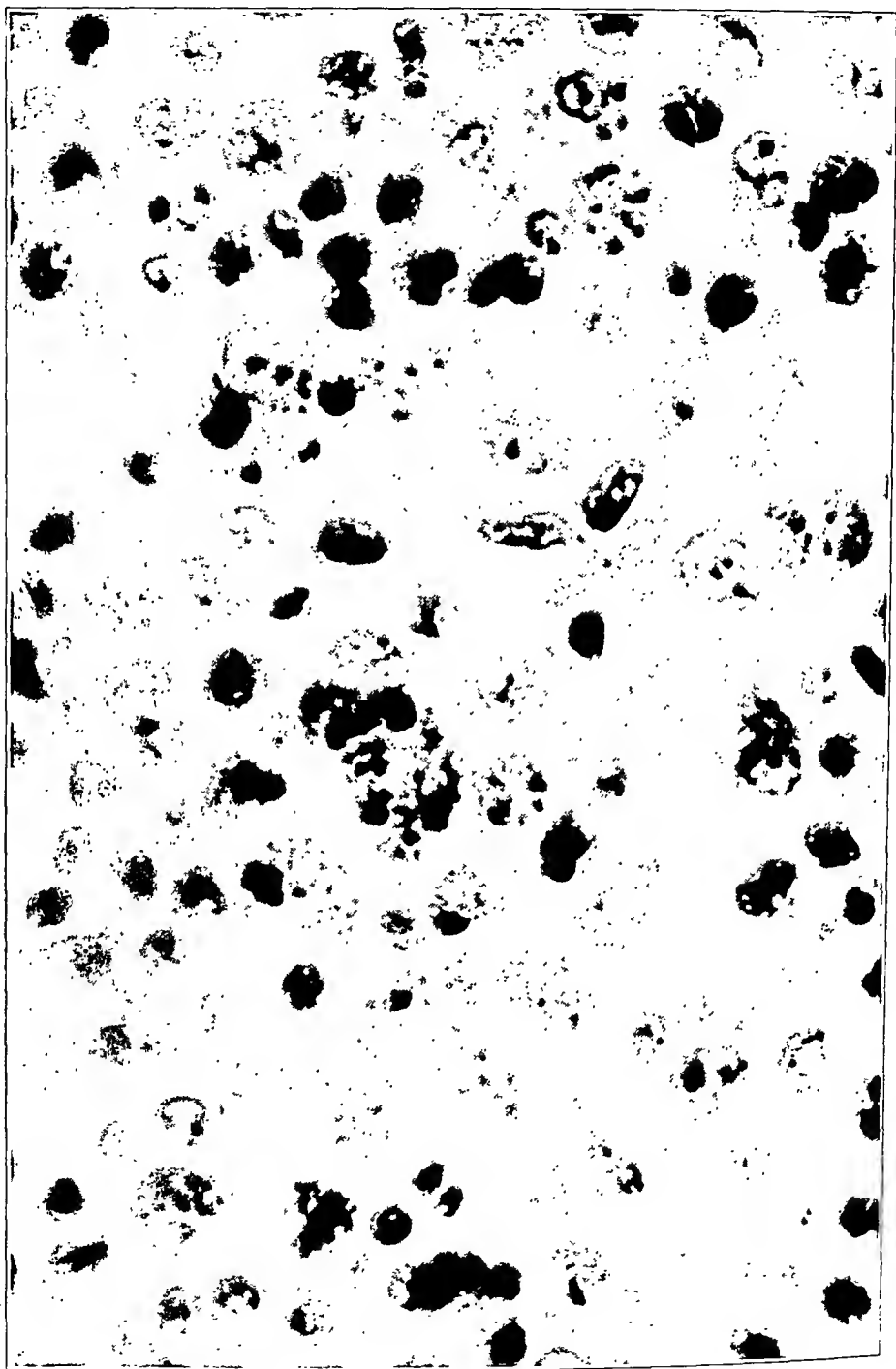


FIG. 1-J

Case 1. C. D. Photomicrograph ($\times 500$) of a section from the head of the fibula. Eosinophiles are a prominent feature of the granulomatous process. There are numerous large mononuclear phagocytes, many of which have a cytoplasm ranging from granular to finely vacuolated. (Hematoxylin and eosin stains.)



FIG. 2-A

Case 2. R. B. May 16, 1938. A large defect of the right ilium adjacent to the acetabulum was the only bone lesion seen in the roentgenograms of this patient.



FIG. 2-B

Case 2. R. B. December 30, 1940. The lesion is healed.

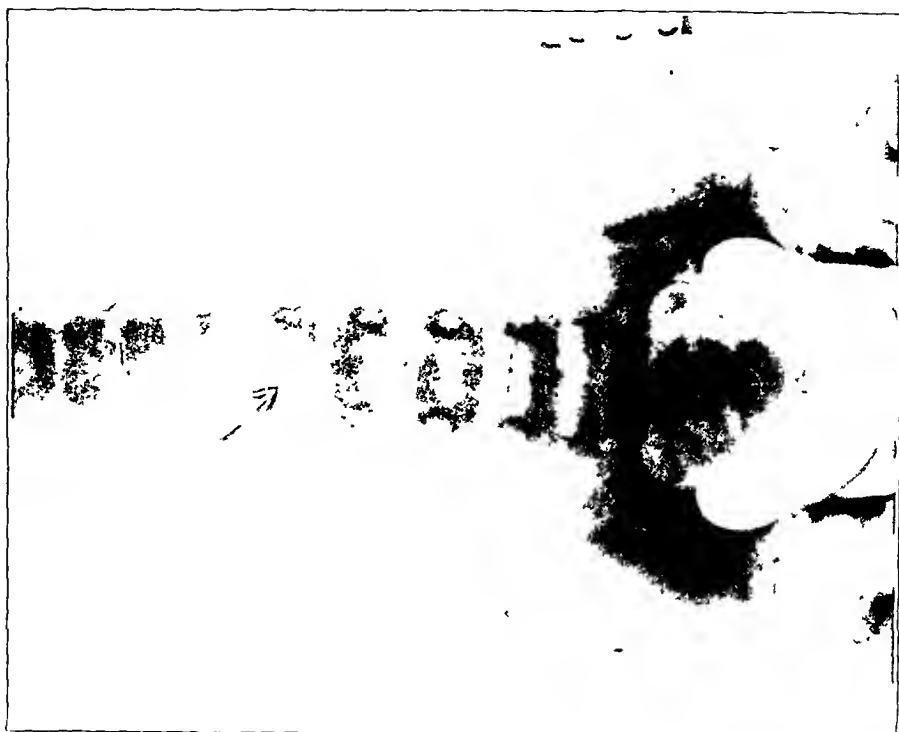


Fig. 3-B

Case 3. R. O. February 9, 1937. Lesions of the vertebrae were untreated. Note new lesion in the eleventh thoracic vertebra with collapse of the vertebra, and surrounding soft-tissue shadows resembling a tuberculous process. Lesions of the ilium are healed.



Fig. 3-A

Case 3. R. O. September 16, 1936. Multiple lesions involving the second and third lumbar vertebrae and the right ilium are seen.



Fig. 3-D

December 14, 1940



Fig. 3-C

July 17, 1939

CASE 3. R. O. Lateral and anteroposterior views of the spine show residual defects of the vertebrae without evidence of activity. Earlier roentgenograms showed the same status. No other skeletal defects remain.

was kept in traction for five weeks, and was allowed to walk after nine weeks. He walked without a limp in September of that same year, three and one-half months after the biopsy.

By roentgenograms, the defect showed definite healing two months after the biopsy, and six weeks after the therapy had been given. Roentgenograms taken one year later showed marked filling-in of the defect.

Examination December 30, 1940, showed a tall, husky boy who seemed entirely well. Roentgenograms at this time showed the defect to have been obliterated.

CASE 3. R. O. (205871), male, aged four and one-half years. Multiple lesions. Two biopsies. Repeated roentgenotherapy. Follow-up four years after the onset: clinically well with healed vertebral deformities.

This boy was admitted on September 16, 1936, with a complaint of pain in his back and right arm of four months' duration. His appetite had been poor, and he had lost some weight. His familial and past history were not important.

Physical examination showed a somewhat pale, well-developed boy who presented a mild kyphos of the upper lumbar vertebrae, with muscle spasm on forward flexion. There was atrophy of the muscles of the right arm, unassociated with tenderness or muscle spasm. He was not particularly ill. His temperature was normal.

Roentgenographic examination showed destructive processes in the right ilium, the second and third lumbar vertebrae (Fig. 3-A), right humerus, right scapula, and skull.

Laboratory determinations were essentially normal:

Red blood cells—4,700,000

Hemoglobin—90 per cent.

White blood cells—11,300

Polymorphonuclear neutrophils—68 per cent.

Lymphocytes—25 per cent.

Monocytes—3.5 per cent.

Eosinophiles—3.5 per cent.

Blood chemistry:

Calcium—9.6 milligrams per 100 cubic centimeters of serum

Phosphorus—4.0 milligrams per 100 cubic centimeters of serum

Phosphatase—0.582 Kay units

Cholesterol—171 and 139 milligrams per 100 cubic centimeters on two determinations

Serum protein—6.7 milligrams per 100 cubic centimeters

Fat—1.49 grams and 0.75 grams per 100 cubic centimeters on two determinations

Phospholipid phosphorus—10 milligrams per 100 cubic centimeters

Intradermal tuberculin test—negative

Hinton test for syphilis—negative.

A biopsy with removal of all recognizable pathological tissue was made on the larger lesion of the ilium on September 22, 1936, and on a lesion of the humerus on October 10, 1936. Bacterial culture gave no growth. Histopathological examination in each instance showed a healed and healing granulomatous process, with small foci of lipophage and other large mononuclear infiltration.

The spine was supported by a plaster body jacket, and x-ray radiation of 400 roentgen units was given to the right scapula and humerus on November 4 and 5, 1936, utilizing two different fields.

Roentgenograms taken December 15, 1936, showed marked healing of the lesions in the treated areas, with considerable healing of the lesion in the ilium, which had been curetted, but which had not had roentgenotherapy. Roentgen examination on February 9, 1937, showed the lesion in the humerus to be completely healed, and that of the ilium practically healed. The untreated lesions of the spine showed increased destruction, and new lesions had developed in other vertebrae, with almost complete collapse of the

body of the eleventh thoracic vertebra, which showed an associated spindle-shaped shadow of the type seen in a tuberculous process (Fig. 3-B).

Roentgenotherapy was given to all recognizable lesions in February of 1937, and the child was maintained in a plaster body shell. The therapy to all areas was repeated on March 23, 1937, and to the thoracolumbar spine on April 24 and May 25, 1937.

The lesions responded rapidly. The child was allowed out of the shell and given a long spinal back brace in September of 1937, which he wore during his convalescent period. At no time was the boy generally ill, nor did he have any temperature elevation.

Examination in December 1940 showed the patient to be clinically well. There were residual deformities of the vertebrae without clinical signs (Fig. 3-D).

CASE 4. *J. K. (196152), male, aged seven years and two months. Single cystlike area in humerus without symptoms. Two biopsies. Five year follow-up examination: well with no residua.*

This patient was admitted September 30, 1935, for treatment of a cystic-appearing area in his right humerus, which had been discovered when a roentgenogram of his chest had been taken. There had been no complaints referable to the arm. The family history gave no significant information. His past history was marked by allergic manifestations, including eczema as an infant, and asthma which had persisted.

Physical examination of the arm was negative, as was the general examination at the time of admission. Roentgenograms of the skeleton revealed no defects other than a large oval area in the shaft of the humerus, about six centimeters from the upper epiphyseal plate, which was interpreted as "a solitary bone cyst" (Fig. 4-A). His temperature was normal.

In the laboratory examination, the routine urinalysis gave essentially normal values. The calcium and phosphorus of the blood were within normal limits on repeated examinations. He did have an eosinophile count of 3 per cent. on admission, and at one time in his course, during an asthmatic attack, this reached 8 per cent. At all other counts, the average was 1 per cent. Total blood lipid was not determined until the lesion was practically healed, and was 0.930 grams. Intradermal tuberculin test in dilution of 1:1000 was negative, as was the Hinton test for syphilis.

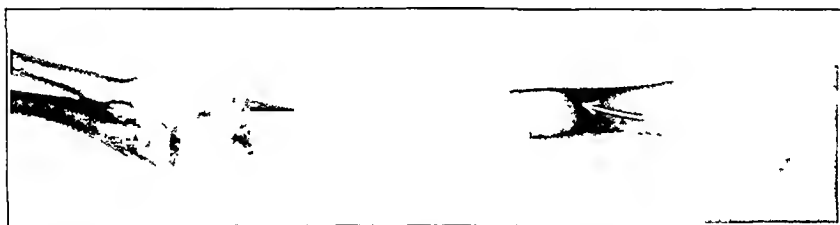


FIG. 4-A

Case 4. J. K. September 28, 1935. The lesion of the humerus suggests a solitary bone cyst.

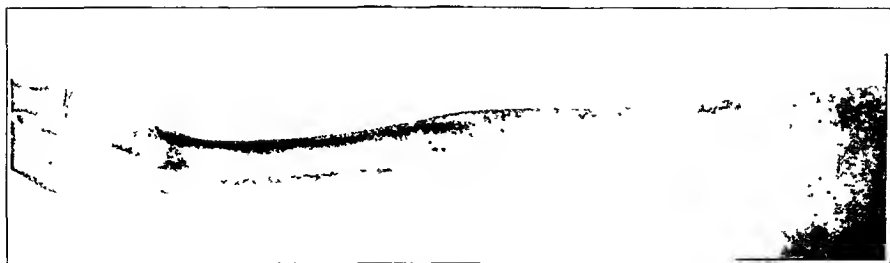


FIG. 4-B

Case 4. J. K. December 30, 1940. Roentgenogram on follow-up examination shows no residual defect.

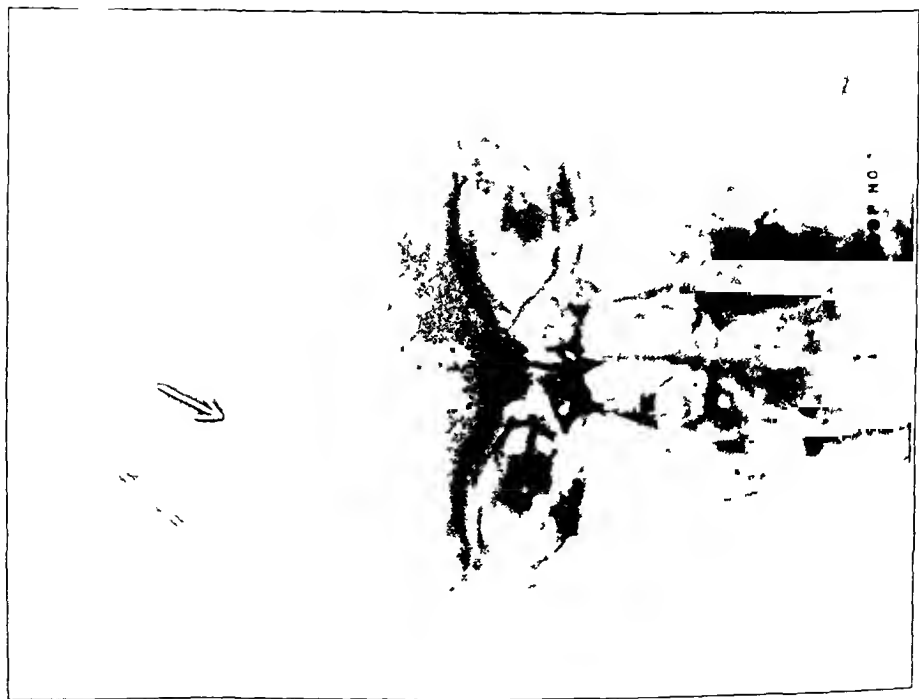


FIG 5-A

Case 5. P. F. Match 7, 1932. There is one very large defect in the frontal bone, with a smaller lesion above it.

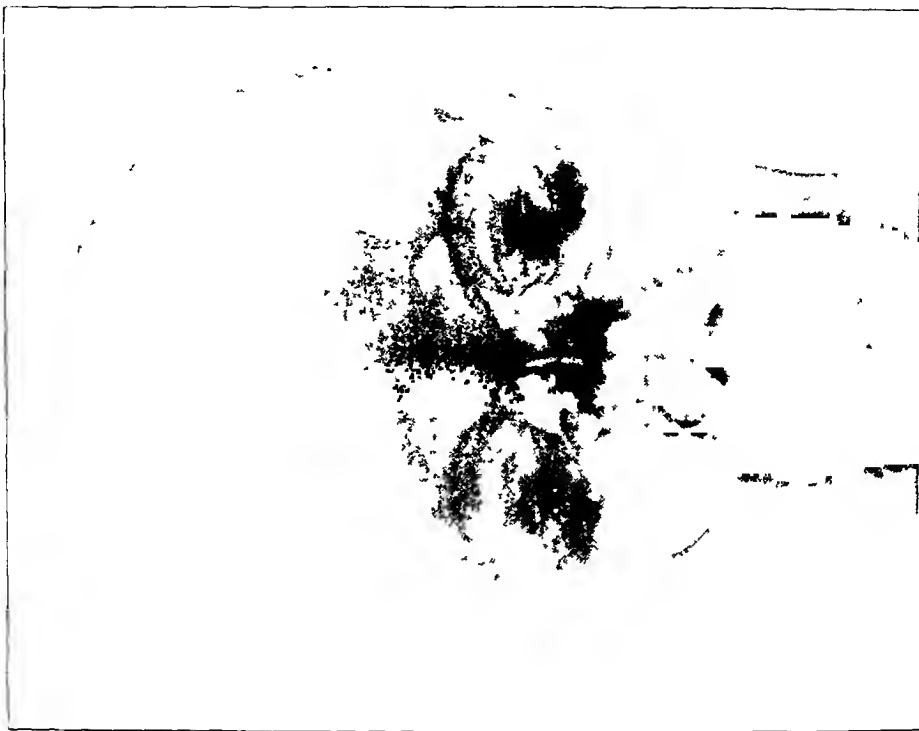


FIG. 5-B

Case 5. P. F. July 17, 1939. At follow-up examination, no residua of defects are seen.

At operation on October 4, 1935, the area in the humerus was explored and found to be filled with "yellow caseous material which was thoroughly curetted until normal bone

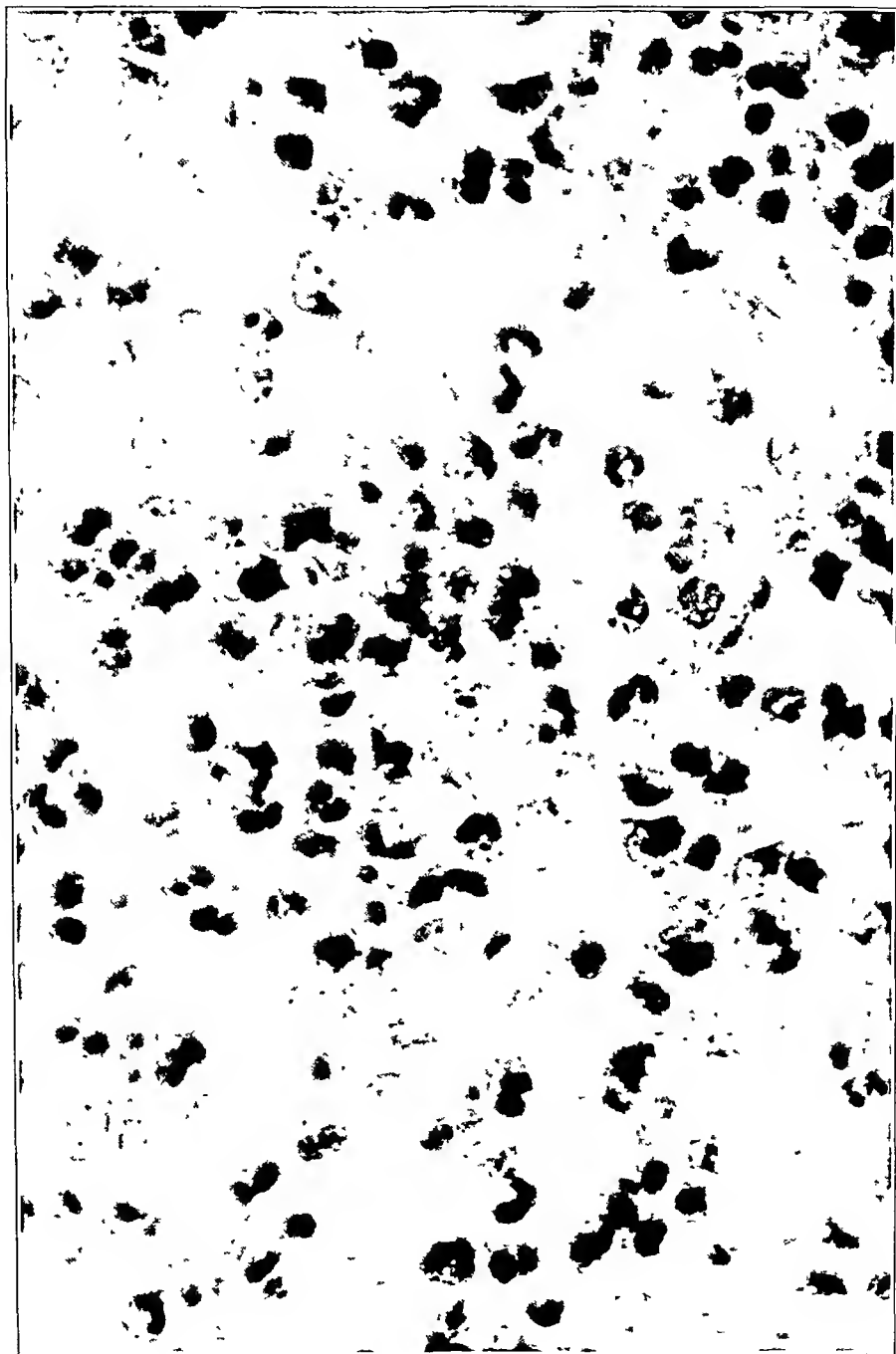


FIG. 5-C

Case 5. P. F. Photomicrograph ($\times 500$) of the tissue removed from the defect in the skull. The process is a granulomatous one in which large numbers of eosinophilic cells are found. In addition, large mononuclear cells with pale cytoplasm are scattered throughout the section. (Eosin and methylene-blue stains.)

was obtained". The wound healed *per primam*. The histopathological findings were similar to those found in the other cases, except for a larger proportion of "foam cells", with eosinophiles not a prominent finding. Culture of the tissue from the area did not reveal any bacterial growth.

Eight weeks later, roentgenograms showed considerable healing, but subsequently the area remained mottled. In October 1936, roentgenotherapy was given to this area through two different fields on successive days.

Since the healing was incomplete, a second curettage of the area was done on May 13, 1937. Microscopic examination showed fibrous-tissue replacement of the disease process.

The defect gradually became obliterated. At a follow-up examination in December 1940, roentgenograms showed complete healing, and there were no other recognizable lesions (Fig. 4-B). Clinically he was well, except for infrequent attacks of asthma.

CASE 5. P. F. (158189), male, aged ten and one-half years. Two lesions in the skull. Biopsy. Roentgenotherapy. Follow-up over eight and one-half years after onset: clinically well, with no residual defect.

This patient was admitted March 7, 1932, with the complaint of swelling of the right side of his forehead of twenty-five days' duration. There were no other complaints. There was no known antecedent illness or injury.

Physical examination showed a well-developed and nourished boy with a soft swelling the size of a plum over the right frontal region. The right supra-orbital region seemed slightly less prominent than the left. Except for carious teeth, the physical examination did not reveal any significant abnormalities. There were no abnormal neurological signs.

In the laboratory examination, the blood and urine showed normal findings. There was no eosinophilia. Blood calcium, phosphorus, cholesterol, and non-protein nitrogen were all normal.

Roentgenograms showed a large circular defect, about four centimeters in diameter, in the right frontal bone just lateral to the mid-line above the orbit. There was another lesion about one and five-tenths centimeters in diameter just above the large one (Fig. 5-A). There were no other bone defects demonstrable in the skeleton.

At operation on March 10, 1932, a portion of the tissue was removed for microscopic examination. Culture of this tissue did not give bacterial growth.

The histological picture was typical of the other cases,—a granulomatous process with numerous lipophages, and with foci of eosinophilic infiltration a prominent feature (Fig. 5-C).

On March 18, 1932, x-ray radiation was given in an approximate dosage of 300 roentgen units, and this was repeated at monthly intervals until a total of six treatments had been given. About 50 per cent. epilation was produced. Roentgenograms taken in July 1932 showed considerable healing of the process. This healing was progressive, and on follow-up examination, over eight and one-half years after the onset, the patient was found to be entirely well clinically. There were no residual defects in the skull (Fig. 5-B).

CLINICAL FEATURES

The clinical course presented by these five patients is representative of that observed in all cases in which the lesions were confined to the skeleton. The process in all these instances was characterized by destructive lesions of bone, either single or multiple, associated almost uniformly with few significant general manifestations.

The ages of the ten patients varied from eleven months to ten years and eleven months. Nine of the ten patients were males; the significance of this sex difference in this series cannot be commented upon at this time. Four patients had single bone lesions, and six multiple lesions.

TABLE I
BONES AFFECTED *

Bones	Single Lesion (4 Cases)	Multiple Lesions (6 Cases)
Skull.....	2	6
Pelvis.....	1	5
Scapula.....		2
Rib.....		21
Vertebra.....		8
Face.....		2
Mandible.....		2
Femur.....		6
Tibia.....		2
Fibula.....		1
Humerus.....	1	7

* Flat bones predominate.

The average number of multiple lesions was sixteen, with the maximum of twenty-five in one patient.

The lesions of the bone, as seen by roentgenography, were variable as to contour, being round, oval, or irregular in outline. They gave a punched-out effect, and did not expand the cortex, though they did on occasion erode through it. There were minimal reactive changes in the bone itself, except in the healing phase. The areas often developed very rapidly, and frequently, after roentgenotherapy, healed equally rapidly.

The distribution and appearance of the process in those with multiple lesions resembled that seen in metastatic malignancy or multiple myeloma, and were identical with the picture seen in Hand-Christian-Schüller disease. Flat and irregular bones predominated (Table I). Of the bones of the extremities, those closest to the trunk were most commonly involved; in no instances were the distal ends of the tibia, fibula, radius, and ulna, or the bones of the hands and feet affected.

The distribution of the lesions in those with multiple areas may be seen in Table I. The maximal number of lesions which were recognized in one patient was twenty-five. In the four patients with solitary lesions, the bones affected were the ilium, humerus, and, in two instances, the skull.

The sites in the individual bones had no particular pattern. They were frequently near an epiphysis, but they were occasionally in the middle of the shaft or in the epiphysis itself. In single lesions, the roentgenographic appearance, as seen in Case 4 (Figs. 4-A and 4-B), might be exactly that of a solitary bone cyst, and, if the epiphysis is involved, a giant-cell tumor might be suggested. In this series, however, lesions of the epiphyses have always been accompanied by other lesions. In one instance of vertebral involvement, there was an associated spindle-shaped soft-tissue shadow resembling that seen in a tuberculous lesion.

The symptoms were mainly those due to the local lesions. Pain and swelling were the most common complaints. Swelling was usually the first symptom when the skull was the site of the initial lesion, whereas pain was the usual presenting symptom in lesions of other areas. The pain was not of significant degree, except in those instances in which the lesions were adjacent to a joint, or in which a pathological fracture occurred. Many of the lesions existed without any complaints or physical signs. In one patient (Case 4), with a single lesion of the shaft of the humerus, the area was discovered accidentally when films of the chest were taken for another condition. Of other symptoms due to the local process, there were two instances of unilateral exophthalmos of mild degree from involvement of the orbital plate, and one of loss of teeth associated with a lesion of the mandible.

Evidences of general illness when the patients were first seen were few. Four had no complaints of a general type on admission, and seemed to be perfectly well except for the presence of the local lesions. Irritability, loss of weight, and anorexia were noted (each in two patients), but these were not marked.

In nine of the ten children, the general health was good throughout the course, except for a moderate anaemia which came on after roentgenotherapy in four instances. In no instances were there any suggestions of diabetes insipidus, dwarfism, mental deterioration, or symptoms referable to the central nervous system. Headache was noted at some time in three of the patients. Fever, attributable to the disease, was not present.

In considering possible etiological factors, attention was given to the history of antecedent infection and trauma. In no instance was it suggested that a preliminary infection was related to the disease, and in only one instance was there a history of trauma. This patient was alleged to have been struck over his right eye with a baseball, approximately three weeks before a swelling was noted in the same area. After the blow, the patient lost consciousness for several minutes. The lesion of the skull was quite large six weeks after the alleged injury, and the question arose as to whether the severity of the trauma might have been apparent rather than real, because of a lesion which was already in existence.

Otani and Ehrlich felt that trauma played some part in the etiology. As evidence, they presented the fact that Schairer felt that injury was the initiating factor in his two cases, and that a history of trauma was present in three of their five cases in which historical information was available. A history of trauma was present in only one of the patients for whom they gave a detailed history. In this instance the ascribed injury was a pull on the arm two weeks before admission, followed by pain and inability to move the arm. Roentgenographic examination on admission was reported to show "an area of bone destruction, fairly extensive, involving the glenoid fossa, and the neck of the scapula and extending along the

outer border". This history would suggest that the trauma merely precipitated symptoms in an already existing lesion, and was not an etiological factor.

The course of one patient in the authors' series differed from that of the others. When admitted, this child had had the disease seven months, and showed a draining sinus in front of the left ear which had developed after operative drainage of what was thought to be an abscess. Despite this, the child was well developed, well nourished, and did not seem particularly ill. He did have a relatively severe anaemia; the red count was 3,500,000 with a hemoglobin of 65 per cent. He presented multiple lesions of the skull, ilium, left femur, humeri, and ribs, which in roentgenographic appearance were similar to those seen in other cases. Tissue removed from one of the lesions presented a histological picture identical to that seen in the other cases. The lesions reacted less well to roentgenotherapy than in many cases, although definite healing in the areas which were treated was noted coincident with the appearance of new lesions in other regions. After fairly extensive roentgenotherapy, a severe anaemia and leukopenia developed, for which blood transfusions were given. The patient seemed to be in good condition at the time of his discharge. He did not return to the Hospital, but it has been established that he died three months later. No details are available.

Laboratory studies were not particularly revealing. Leukocytosis was present on admission in six of the ten cases, averaging 15,800 in those instances where it was elevated. In one instance there was an eosinophilia of 6 per cent., but this followed roentgenotherapy. In three other patients the percentage of eosinophiles was 3 per cent. on one determination, but at a lower level on all other occasions. In another patient, 8 per cent. eosinophiles were present during an asthmatic attack, but his differential blood count was within normal limits at other times. Lichtenstein and Jaffe pointed out the presence of eosinophilia of from 4 per cent. to 10 per cent. in their cases.

Chemical examination of the blood revealed the phosphorus, calcium, and phosphatase to be normal in all instances where such determinations were made. The total lipid of the blood was above one gram in four of the nine cases on one determination, but when the examination was repeated, normal figures were obtained. The phospholipid phosphorus of the blood was normal in the eight cases in which it was studied.

The values for blood cholesterol and cholesterol ester showed no significant variations from the accepted normal. The total protein of the blood, as well as the albumin-globulin ratio, was determined in several instances, and in all the findings were normal. The urine was examined for Bence-Jones protein and in no instance was it found. The intradermal tuberculin test and the Hinton test for syphilis were done in all cases, with negative findings. Culture of the biopsy site, in many instances anaerobically as well as aerobically, gave no bacterial growth.

PATHOLOGY

The pathological picture presented in the different cases showed considerable variation. As tissue removed at operation accumulated in the course of this study, stages in what appeared to be the life history of the process could be defined. The destructive lesion in bone is essentially a granulomatous one, with variations which appear to depend upon the duration of the disease process, the degree of destruction of bone, and the amount of repair. What may be interpreted as the *early* lesion consists of areas of bone destruction infiltrated by large numbers of cells, most of which are either eosinophiles or large mononuclear cells which are actively phagocytic. The eosinophiles are either mature leukocytes or, as is frequently the case, eosinophilic myelocytes. They may be gathered in large clumps or masses in such a way that the field is discolored a bright red by their presence, or they may be scattered diffusely through the entire section. Accompanying the eosinophiles are variable numbers of plasma cells, lymphocytes, and small foci of polymorphonuclear leukocytes unassociated with bacterial infection or abscess formation. The large mononuclear cells vary considerably in size. Usually the large mononuclear cells have round to oval or horseshoe-shaped nuclei, and possess cytoplasm which is either coarsely granular, definitely vacuolated, or frankly "foamy" in character. Frequently present in the large mononuclear cells are fragments of eosinophiles or polymorphonuclear leukocytes, bits of intact bone, or unrecognizable debris. Either the foci of eosinophiles or masses of large mononuclear cells may dominate the picture. Often gathered around the masses of large mononuclear phagocytes, with or without vacuolated cytoplasm, there may be found large numbers of myelocytes, not all of which are eosinophilic, giving a suggestion of intense stimulation of the bone marrow which, when first seen, may suggest myelocytic myeloma.

In a somewhat *older* stage of the disease process, eosinophiles are no longer present. Now large mononuclear cells, most of which are vacuolated, represent the most common cell found, and fibroblastic ingrowth is evident. A little later stage of this same process may show complete vacuolization of the large mononuclear cells—which may now be called lipophages—giving an appearance typical of the "foam" cells of xanthoma. In a still later stage of the disease the entire granulomatous process is replaced by connective tissue, which in turn will be transformed into bone.

Scharlach-R stains demonstrate in the early stage of the disease, even in areas where eosinophilic infiltration is most marked, a large amount of stainable lipid which is sometimes doubly refractile. This material does not stain positively by the Smith-Dietrich method for sphingomyelin. In the somewhat older lesions when lipophages are more common, a larger amount of stainable lipid may be demonstrated by the Scharlach-R method. The impression is gained from the study of a number of specimens that, as the lesion progresses and the area of

bone destruction is being repaired, lipid is released in increasingly large amounts, and is taken up by large mononuclear phagocytes (lipophages).

In none of the material available for study was there evidence of a bacterial infection. Sections of tissue stained by appropriate methods disclosed no bacteria either within or between the cells. A small number of animal-inoculation studies revealed no evidence of a living agent, and attempts to culture a bacterium by anaerobic, aerobic, or partial-tension techniques were unsuccessful. A few efforts were made to demonstrate the presence of a possible virus, but insufficient studies have been made to exclude its presence.

TREATMENT AND PROGNOSIS

The treatment was originally evolved by pure empiricism. It was found that most of the lesions responded to roentgen radiation in relatively small doses. In other instances, they have healed following partial excision and curettage. Healing has occurred spontaneously in two lesions of this series, both of vertebrae, but in each instance there was residual deformity.

The roentgen radiation in the earlier cases was essentially that of a technique involving a single dose of 400 roentgen units, which produced a mild erythematous reaction. A typical treatment may be recorded as follows: 160 kilovolts, five milliamperes, at a distance of forty centimeters, with a filter of four millimeters of aluminum. Frequently this dosage was given to the same area through another field one month later. On occasion, however, at the original treatment, the dosage above was used on successive days.

The technique utilized in the later cases is typified by Case 2, in which a total of 1500 roentgen units was given through two fields, in divided doses over a six-day period. The details of the daily exposure were recorded as: 160 kilovolts, five milliamperes, at a distance of forty centimeters, for twenty minutes. The filter was one-fourth of a millimeter of copper and one millimeter of aluminum.

No significant difference in result has been noted from the two techniques. Twelve was the maximal number of treatments to any one bone. These were given, over a period of twenty-one months, to the skull (Case 1), where new lesions were appearing as the old ones healed. In cases with multiple lesions, there is a distinct advantage in keeping the dosage to any one area at a relatively low level.

In five of the patients, lesions appeared in new areas while the original lesions were being treated. In one instance, a new lesion appeared two years and eight months after the known onset of the disease. All lesions were interpreted by roentgenograms as completely healed on an average of one year and seven months after admission. Often in a few months the healing was so complete that the site of the former lesion could not be recognized.

A recent examination of the nine living patients of this series revealed

TABLE II
SUMMARY OF ALL CASES

Hospital Case No.	Name	Age	Sex	Admitted	Duration of Symptoms	Lesions	Last New Lesion †	Healed *	Follow-Up *
150020	R. B.	4 years, 4 months	F	Apr. 15, 1933	3 weeks	Single	None	1 year, 6 months	7 years, 8 months
196152	J. K.	7 years, 2 months	M	Sept. 30, 1935	?	Single	None	2 years, 7 months	5 years, 3 months
202932	K. Mc.	10 years, 11 months	M	June 8, 1936	1½ months	Single	None	11 months	4 years, 6 months
222051	R. B.	4 years, 7 months	M	May 16, 1938	3 weeks	Single	None	1 year, 2 months	2 years, 7 months
143166	J. T.	3 years, 8 months	M	Oct. 6, 1930	1½ years	Multiple	1 year, 2 months	2 years, 6 months	10 years, 3 months
158189	P. F.	10 years, 6 months	M	Mar. 7, 1932	1 month	Multiple	None	1 year, 2 months	8 years, 9 months
163932	C. D.	2 years, 1 month	M	Aug. 18, 1932	2 weeks	Multiple	1 year	2 years, 7 months	8 years, 4 months
183732	T. N.	11 months	M	July 16, 1934	2 months	Multiple	8 months	1 year, 3 months	6 years, 5 months
205871	R. O.	4 years, 6 months	M	Sept. 16, 1936	4 months	Multiple	5 months	10 months	4 years, 3 months
194161	N. G.	2 years, 4 months	M	July 20, 1935	7 months	Multiple	11 months	Dead	Dead
Average		5 years, 1 month			4 months			1 year, 7 months	6 years, 5 months

* Period of time after admission.

† Lesions developing while under observation.

that all seemed to be entirely well (Table II). There were residua in three instances: One patient had an adentulous jaw, and in two others residual deformities of vertebrae were seen in the roentgenograms, without symptoms or recognizable clinical deformity. The follow-up interval averaged six years and five months after the original admission,—the longest being over ten years; the shortest, two years and seven months.

One patient died. He was not followed throughout the course of the disease and the cause of his death is not known.

Certainly the prognosis for healing of the individual bone lesions is good, but if the suggested relationship of this condition with Hand-Schüller-Christian disease and Letterer-Siwe disease exists, the general prognosis at the outset should be guarded. The authors have seen a fatal outcome in patients whose bone lesions seemed to be identical with those in this series, but who in addition had visceral lesions.

DIAGNOSTIC CONSIDERATIONS AND COMMENT

This process must be considered in differential diagnosis whenever destructive lesions of bone, either single or multiple in occurrence, are encountered. The lesion has been noted much more commonly in children than in adults. One of the authors has had the opportunity to study specimens removed at operation from several adults. It is probable that many more examples of this disease will be recognized as knowledge concerning its clinical and pathological characteristics becomes disseminated.

When the lesion is present in solitary form, clinical and roentgenographic differentiation from osteomyelitis, tuberculosis, syphilis, solitary bone cyst, and giant-cell tumor must be considered. When multiple lesions are present, multiple myeloma, metastases of neuroblastoma or of lymphoma, and osteitis fibrosa cystica of the generalized form are some of the differential considerations in interpretation of the roentgenograms. The problem varies with the number of lesions and their sites.

The similarity in roentgenographic appearance of the lesion under discussion and tuberculosis, is suggested by the destructive nature of the process without the formation of new bone. In one instance in this series, a lesion of a vertebra was associated with a paravertebral shadow similar in outline to a tuberculous process. The tuberculin test may be used as an aid in making the diagnosis of tuberculosis. When syphilis is considered, the Hinton test may be of value.

In certain instances it is impossible to differentiate the solitary form from a bone cyst except by histological examination. The same may be said of osteomyelitis, although osteomyelitis usually is accompanied by more evidences of generalized illness—such as fever, pain, and reaction in the surrounding soft tissues—as well as roentgenographic evidences of new bone formation.

Multiple myeloma will be suggested by the roentgenographic manifestations of the multiple form of the disease. Laboratory studies, such as a search for the Bence-Jones protein and the albumin globulin ratio,



FIG. 6-A

November 16, 1928. E. T., male, with a classic picture of Hand-Schüller-Christian disease. Note the areas of destruction in the skull. This x-ray was taken about seven weeks after admission, and was chosen since it shows the lesions more clearly. (*Reproduced through the courtesy of the American Journal of Roentgenology and Radium Therapy*⁸.)



FIG. 6-B

July 3, 1930. Note the areas of destruction in the ilium.

may be helpful on these occasions. True multiple myeloma has not been encountered in a fairly large experience with tumors in infants and children in this Hospital.

Pain is usually a more prominent feature in instances of Ewing's tumor than in this disease. In Ewing's tumor, also, the area of involvement as shown in the roentgenograms is usually not so circumscribed, and there is likely to be considerable subperiosteal new-bone formation. Multiple punched-out defects of bone may be found in leukaemia, but these defects are usually smaller and more generalized than in the disease under consideration. Hematological study should be sufficient to exclude the diagnosis of leukaemia. The diagnosis of metastatic lesions in the skeleton from a neuroblastoma may be made with certainty by the finding of the primary tumor. The bone changes of hyperparathyroidism are accompanied usually by significant alterations in the levels of calcium, phosphorus, and phosphatase in the blood. No alterations of these values are found in the disease under consideration, nor are there any generalized skeletal changes such as occur in hyperparathyroidism. The bone lesions of the disease process under consideration have an identical roentgenographic appearance with those of Hand-Schüller-Christian disease.

A general statement may be made that, although the disease may be suspected on clinical and roentgenographic grounds, a positive diagnosis is possible only when clinical and roentgenographic data are correlated with the histological examination of biopsy material. Positive recognition of the nature of this disease at any one of the several stages of its development, on histological grounds alone, is possible only if the variations in the life history of the process are known. Before the granulomatous character of the lesion was recognized, diagnoses such as a "pe-



FIG. 6-C

FIG. 6-D

E. T. Photographs of patient at the age of nine years, six and one-half years after the onset of symptoms. The patient is now a blind, mentally retarded dwarf.

culiar form of osteomyelitis", or a "neoplasm, probably an atypical myelocytic myeloma", were made by many pathologists. Such diagnoses were made by one of the authors (S. F.) on material removed from the

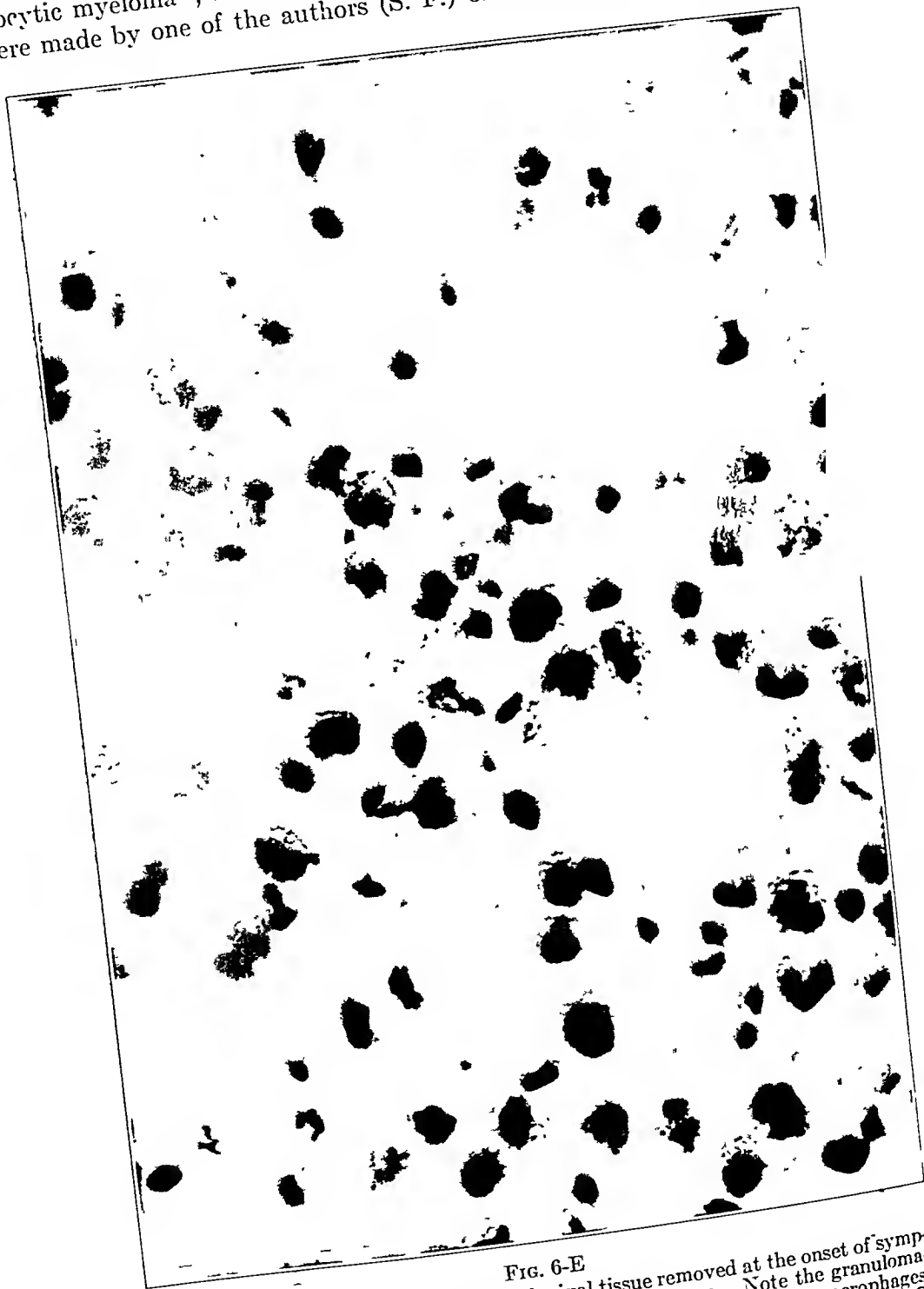


FIG. 6-E

E. T. Photomicrograph ($\times 500$) of gingival tissue removed at the onset of symptoms, when the patient was two and one-half years of age. Note the granulomatous process with large numbers of eosinophiles and pale lipid-laden macrophages. The process closely resembles the lesions of bone illustrated in Figures 1-J and 5-C. (Hematoxylin and eosin stains.)

first few patients examined in this Hospital. The reaction of the bone marrow to the destructive process may be so striking as to suggest a tumor of the blood-forming tissues.

The similarity of the roentgenographic and histological picture to that of Hand-Schüller-Christian disease may be illustrated by consideration of one of the patients, who has been observed with typical Hand-Schüller-Christian disease. This case was originally described twelve years ago in a paper by Sosman (Case II)⁸, and has since been observed.

E. T., male, aged two and one-half years, was admitted to The Children's Hospital on September 25, 1928, with a complaint of polydipsia and polyuria, stomatitis, and loss of weight of six months' duration. Marked exophthalmos later developed. The clinical picture was typical of Hand-Schüller-Christian disease, and the laboratory findings were consistent with this diagnosis. X-rays showed multiple destructive lesions involving the skull, mandible, and ilium (Figs. 6-A and 6-B). (These lesions were indistinguishable roentgenographically from those characteristic of the disease under discussion.)

Histological examination was made of a cervical lymph node and of gingival tissue which surrounded a loose molar tooth (Fig. 6-E). In both specimens the predominant reaction was a granulomatous one, characterized by the presence of large numbers of eosinophiles and numerous pale lipid-laden cells. The lesions involving the skeleton healed after roentgen radiation, with new lesions appearing simultaneously in other areas, just as in certain cases of this series.

At a follow-up examination eleven years after the onset of the symptoms, the patient was a blind, feeble-minded dwarf, who exhibited marked spasticity. Roentgenographic examination at this time showed that all defects of the skeleton had healed except for a few small areas in the skull which had remained unchanged since the last examination one year before, and were apparently residual defects in ossification.

This patient had the classic symptomatology of Hand-Schüller-Christian disease, yet roentgenographically the lesions were similar to those of the cases in this series. With allowance made for the anatomical differences in the tissues, which were the site of the lesions, the process in this patient appeared to be identical in histological appearance to the destructive lesions of bone described under the term "eosinophilic granuloma" of bone.

The data upon which Farber bases his conclusions, that this disease is but a variant of the basic process of which Letterer-Siwe disease and Hand-Schüller-Christian disease are other examples, are presented elsewhere.² Since the etiology of the process is unknown, there is no rational basis for a name to apply to the disease. In the records of these cases, for convenience, the process has been designated by the term "destructive granuloma of bone", "single" or "multiple" as the case may be, adding parenthetically, "Hand-Schüller-Christian syndrome".

SUMMARY

1. Ten cases of benign destructive lesions of bone, either single or multiple, which appear to be identical with what has been described in the recent literature as "eosinophilic or solitary granuloma of bone", are presented. All were in children under twelve years of age.

2. Roentgenographically, single lesions simulated bone cyst, osteomyelitis, or malignancy. Multiple lesions suggested multiple myeloma

or malignancy, but in the roentgenograms were indistinguishable from Hand-Schüller-Christian disease.

3. There was little general illness associated with the disease in most instances. The symptoms were attributable mainly to the local process.

4. The histopathology presented variations from "eosinophilic granuloma" to "lipogranuloma", which is interpreted as identical with certain stages of Hand-Schüller-Christian disease.

5. Ordinarily, the lesions have healed quite promptly after roentgen radiation, and, on occasion, after curettage.

6. Nine of the ten patients were well on a follow-up examination three to ten years after they were first observed. One had died, the details of which case are unknown.

7. As suggested by one of the authors in a previous communication, eosinophilic or solitary granuloma is not a distinct new entity, but a variant of the basic process of which the clinical pictures known as Hand-Schüller-Christian and Letterer-Siwe diseases are other examples.

8. Despite the excellent prognosis in nine of the ten patients in this group, in which the recognized lesions were restricted to bone, if the suggested relationship to Hand-Schüller-Christian disease exists, the prognosis given in an individual case should be guarded, and the possibility of visceral lesions should be kept in mind.

Thanks are expressed to William E. Ladd, M.D., Chief of the Surgical Service of The Children's Hospital, for transferring to one of the authors (W. T. G.) certain patients in this group who were originally admitted to his service; and to Allan M. Butler, M.D., for the chemical determinations cited in this paper.

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THE PATHOLOGY OF TUBERCULOSIS OF THE SPINE *

BY MATHER CLEVELAND, M.D., AND DAVID M. BOSWORTH, M.D.,
NEW YORK, N. Y.

For the past six years the authors have been investigating all available material to determine, if possible, the localization, type, and method of invasion of tuberculosis of the adult human spine. We had been taught to believe that the lesion began in the intervertebral disc. When studies of gross and microscopic sections obtained at autopsy were begun, this idea could not be verified. Certain salient facts regarding the vertebral column or spine must be given due weight. The main intervertebral joints are of the amphiarthrodial type designated as symphysis. The only diarthrodial joints are the small intervertebral articulations situated posteriorly. The amphiarthrodial joint consists of a large intervertebral fibrocartilaginous disc, with vertical fibers closely adherent to the adjacent bone above and below, surrounded on its outer margins by perichondrium. This type of joint has no capsule or synovial lining. Lewis and Stöhr state, "Fibrocartilage in its early development, as seen in the intervertebral disc of an embryo, is primarily fibrous. It is composed of anastomosing bundles of fibers which blend with the matrix of the adjacent vertebral cartilage. Around every cartilage in the adult there is a connective-tissue envelope of perichondrium. Since perichondrium is the formative layer, a more or less perfect regeneration of cartilage may occur after surgical operation if the perichondrium is left in place. The perichondrium contains vessels and nerves, none of which penetrate the matrix of the cartilage."

Since the main intervertebral joint is not diarthrodial, is without a capsule or synovial lining, and has no blood vessels, the ordinary method of implantation of tubercle infection, as an embolic process, cannot apply to the intervertebral disc. The lesion must, therefore, begin in the bone or in the surrounding soft tissue which has an adequate blood supply. The disease may begin in the diarthrodial joints posteriorly, but this is not so frequently seen.

With these facts in mind, the authors have examined numerous specimens of the human spine which have been invaded by tuberculosis, and there have been found two constantly recurring gross pathological states in the bone,—namely, (1) caseation, and (2) sclerosis. At times a combination of these two conditions is seen.

CASEATION

Caseation, a destructive or lytic phenomenon, has been noted, beginning in the bone, the surrounding soft tissue, and the perichondrium.

* Read at the Annual Meeting of The American Academy of Orthopaedic Surgeons, Atlantic City, New Jersey, January 13, 1942.

It has not been noted in any instance in the intervertebral disc until massive destruction has occurred in the adjacent bone or soft tissues, and when this happens the remnant of the intervertebral disc is usually seen as a coagulated slough, not as a caseous mass.

SCLEROSIS

Sclerosis of the vertebral body has been seen with great frequency. It is difficult to reconcile this finding with tuberculosis, which is a lytic lesion. The authors have, therefore, concluded that this phenomenon of sclerosis is due to a massive loss of blood supply, and is caused indirectly by the disease. The following findings are presented to support the contention that sclerosis of bone found in tuberculosis of the spine is due to interference with the vascular supply.

1. Sclerosis of the vertebral body is seen grossly with a typical pattern of infarction extending away from an area where the blood supply has been removed from the vertebral body.

2. Sclerosis of the vertebral body is not seen unless there has been a massive dissecting abscess which strips the soft tissues and blood supply from the bone, or an obliterating vascular process,—such as thrombosis or endarteritis. The mere presence of a massive abscess in contact with bone will not explain these sclerotic changes. For instance, the radial head completely surrounded by the tubercular debris of a massively destroyed elbow joint remains intact, because its blood supply, which comes upward through the radial shaft, cannot be interrupted by pressure, thrombosis, vascular obliteration, or soft-tissue stripping.

3. That sclerosis of the vertebral body is essentially an aseptic necrosis due to loss of blood supply, is emphasized by a study of the microscopic pathology of these lesions. A microscopic section from a sclerotic area in a vertebral body adjacent to new blood supply will show bone production; a similar section in an area remote from any possible new blood supply will show little or no evidence of regenerative bone change.

4. Further microscopic study of sclerotic vertebral bodies shows areas of necrosis which are coagulative, due to ischaemia. When the phenomenon of sclerosis is encountered alone, there is no caseation.

While these two gross findings in the bone are frequently seen in combination, caseation or sclerosis may be found alone. When caseation only is found, it is a relatively early process. Where massive destruction has taken place, sclerosis will also be present, because invariably there will ensue vascular changes, such as thrombosis and endarteritis, which will affect the vertebral bodies.

The authors' study of the pathology of tuberculosis of the human spine has been revealing in many ways. Specimens have been seen with dissecting abscesses extending throughout the entire thoracic and lumbar spine, stripping the soft tissues and blood supply from the anterolateral margins of the vertebral bodies, while the posterior surfaces were uninvolved. The vertebral bodies show multiple sclerotic areas due to inter-



FIG. 1-A



FIG. 1-B

S indicates site from which soft tissue was removed for microscopic study; *B* marks the place where bone was removed for microscopic study. (This applies to other gross specimens also.)

ference with blood supply. In other instances complete sclerosis of vertebral bodies has been seen, which must have been present for several years, without collapse of the vertebrae. It is possible that collapse failed to occur because these vertebral bodies were extremely hard, and their ischaemic state rendered them invulnerable to attack by the bacterial and toxic processes.

These sclerotic lesions of tuberculosis of the spine have been frequently observed to progress very slowly, whereas the lytic lesions, where there has not been much loss of blood supply to the vertebral bodies and the disease is free to act unhampered, may progress rapidly with marked destruction and resulting kyphosis.

The frequent aspiration of an abscess due to tuberculosis of the vertebrae will do much to prevent further stripping of the soft tissue from the vertebral bodies: thus further ischaemic necrosis may be minimized.

The roentgenogram of the spine has its limitations, and it frequently fails to reveal the presence or the extent of invasion by tuberculosis. The authors have searched in vain for roentgenographic evidence of tuberculosis in many spines which have been massively invaded, and where post-



FIG. 1-D



FIG. 1-C

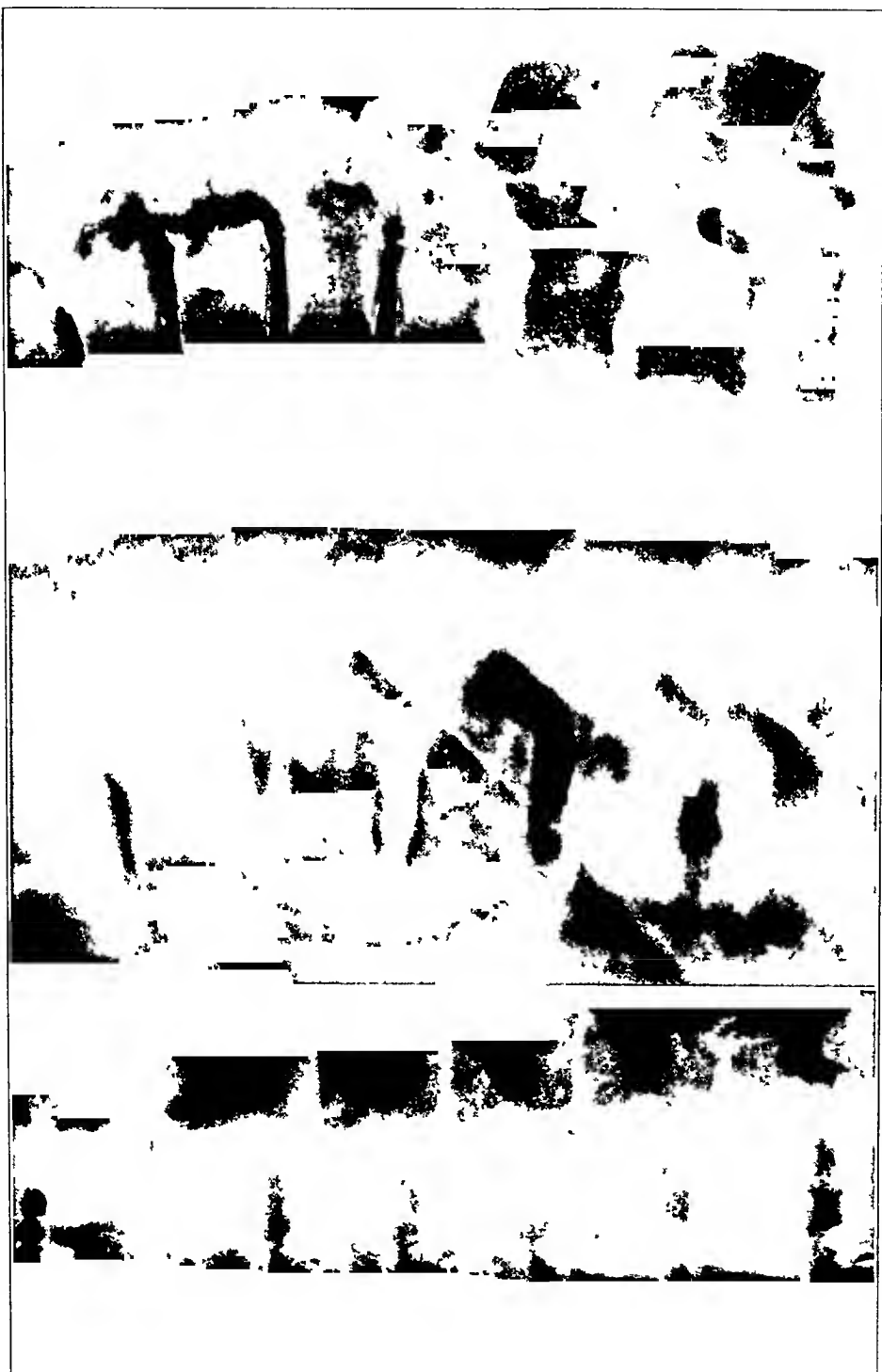


Fig. 1-G

Fig. 1-F

Fig. 1-E

mortem examination has yielded abundant evidence of the disease. There are certain roentgenographic findings previously overlooked which are now recognized—such as sclerosis or mottling of the vertebral bodies in a known tuberculous patient—which lead to an earlier diagnosis of the disease than was formerly possible.

Fusion of the spine is purely a mechanical aid. It may arrest damage until the new productive changes, which are frequently associated with sclerosis due to ischaemia, are able to heal the defect. If there are no areas of living bone to act as centers for creeping replacement, healing may be prolonged indefinitely or may fail to occur. Under these latter circumstances technically adequate fusion may fail to arrest the disease.

The accompanying gross, microscopic, and roentgenographic studies of specimens of the human spine are submitted in support of these conclusions. (See legend for Figures 1-A and 1-B.)

Specimen No. 25.

B. M. (Sea View Hospital No. 15434). The gross specimen (Figs. 1-A and 1-B), which has been split to show a hemisection of the vertebrae from the medial and lateral aspects, shows an invasion of numerous vertebral bodies by exudative granulation tissue, and small abscesses of the soft tissues on the lateral surface around the ribs, but no massive dissec-



FIG. 2-A



FIG. 2-B

tion of the vertebral bodies except posteriorly in two areas. The process is essentially a caseous or destructive tuberculous lesion, primarily in the bone, but with secondary abscess formation in the soft tissue.

The photomicrograph of the soft tissue (Fig. 1-C) shows the wall of an abscess cavity with round-cell inflammatory reaction extending into the surrounding fibrous tissue. A blood vessel, nerve trunk, and spinal ganglion are seen.

The photomicrograph of the bone (Fig. 1-D) shows a destructive lesion of bone with degeneration, fragmentation, and inflammatory round-cell infiltration, a picture of bone necrosis and liquefaction typical of a caseous or destructive type of lesion.

The roentgenograms, anteroposterior and lateral (Figs. 1-E and 1-F), taken before death, fail to reveal any evidence of the disease in spite of its great extent. The intervertebral spaces are wide. The roentgenogram of the washed specimen (Fig. 1-G) still shows very little definite evidence of disease in the vertebral bodies except for slight mottling.

Specimen No. 12.

H. H. (Sea View Hospital No. 11935). The gross specimen split longitudinally (Figs. 2-A and 2-B), shows the lateral aspect of the vertebrae and the interior of the vertebral bodies. There is marked sclerosis, of the wedge-shaped type, of three vertebral bodies which indicates a loss of blood supply. The cause of this infarction is a stripping of the soft tissue from the bone. The central intervertebral disc shows a sloughing of its nucleus, because the perichondrium has lost its blood supply. The posterior elements—that is, the pedicles and articular facets—have been grossly invaded. In this instance it is quite likely that the disease began in the posterior elements, and the sclerosis of the first and third vertebral bodies from above downward was caused by dissection of the covering soft tissue, thrombosis, and endarteritis extending from behind forward.

The photomicrograph of the soft tissue (Fig. 2-C) shows massive caseous necrosis and debris, with granulation tissue and round-cell infiltration. There is seen a nerve trunk surrounded by collagenous fibrous tissue.

The photomicrograph of bone (Fig. 2-D) shows necrosis and degeneration of bone, with fragmentation. The necrotic area is covered with new bone formation, which probably represents repair. The interstices between bone structures show coagulative necrosis. This section was taken from an area where new blood supply was available. This specimen is typical of sclerosis due to loss of blood supply.

The anteroposterior and lateral roentgenograms of this area of the spine (Figs. 2-E and 2-F), taken before death, show a slight thinning of the joint space between two vertebrae, and a suggestion of sclerosis of the vertebral body below the thin intervertebral space.

The roentgenogram of the split and washed specimen (Fig. 2-G) shows the thin joint space and very evident sclerosis of the vertebral body below this space, and some sclerosis of the two vertebral bodies above.

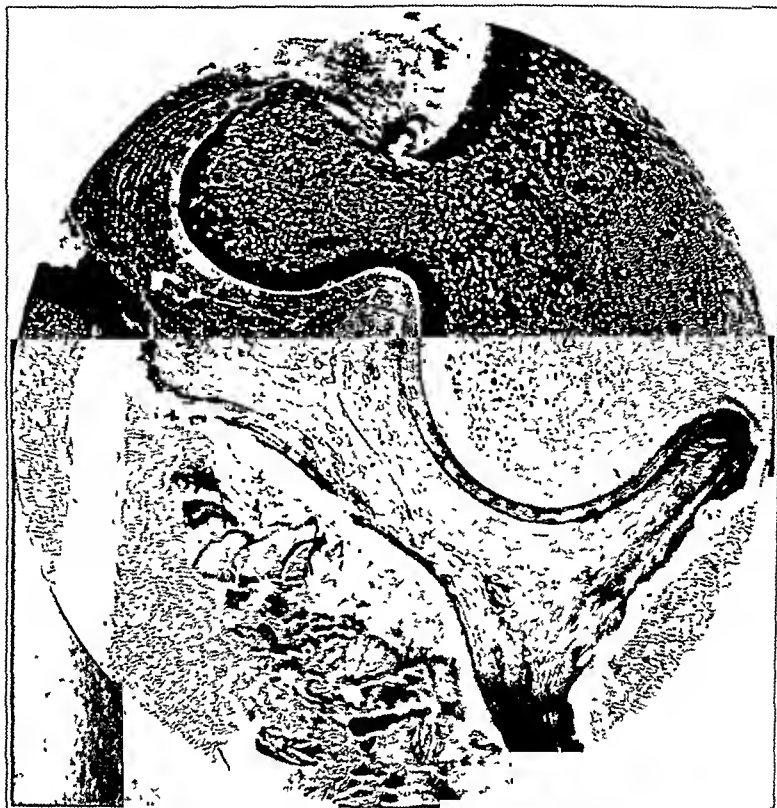


FIG. 2-D

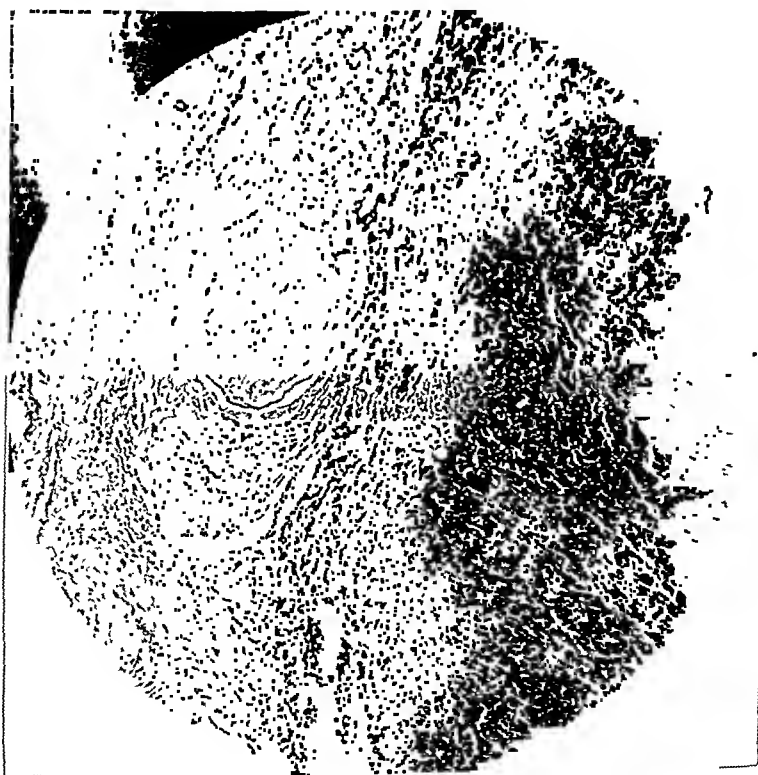


FIG. 2-C

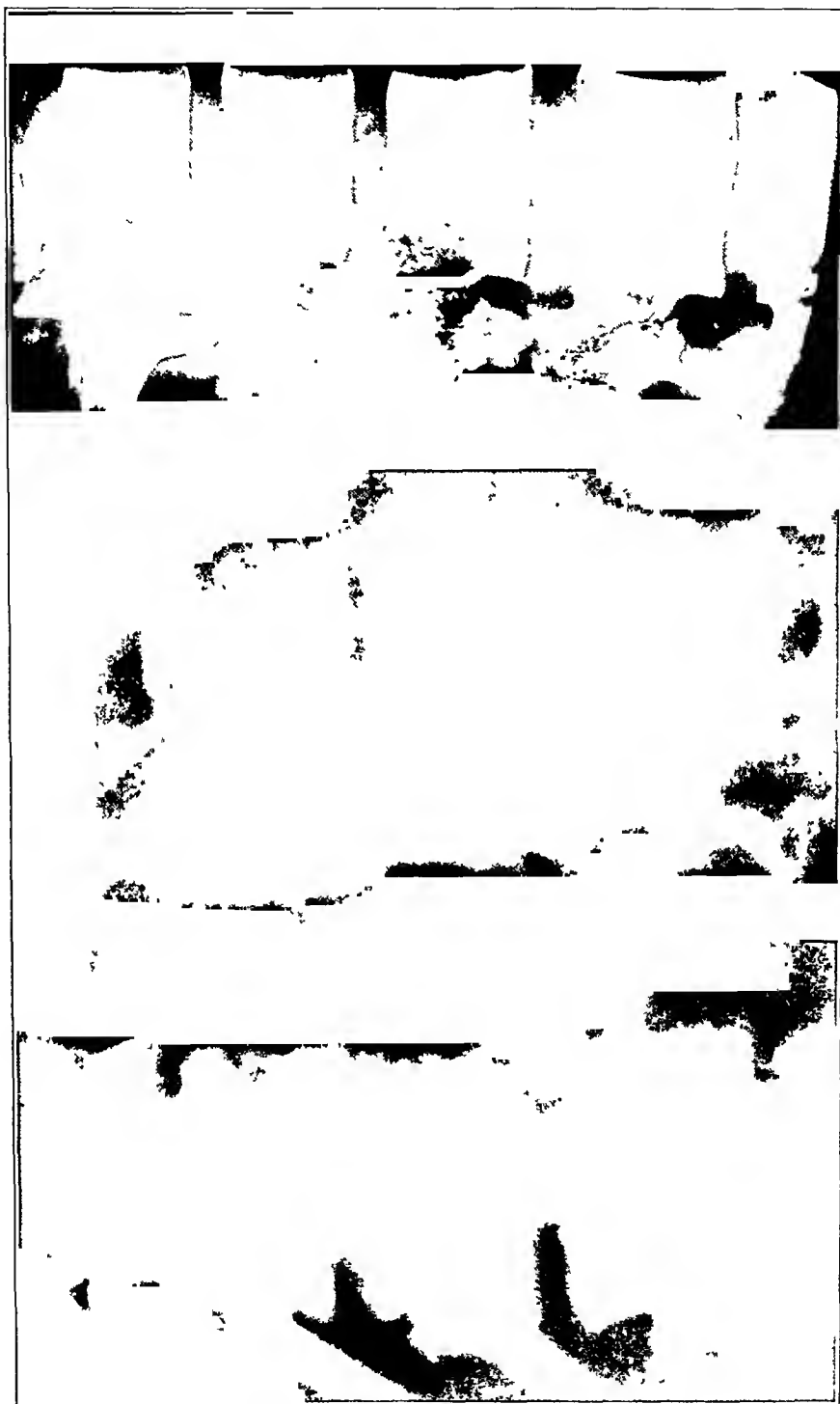


Fig. 2-G

Fig. 2-F

Fig. 2-E

Specimen No. 14.

J. B. (Sea View Hospital No. 11467). shows a longitudinal hemisection of two vertebral bodies

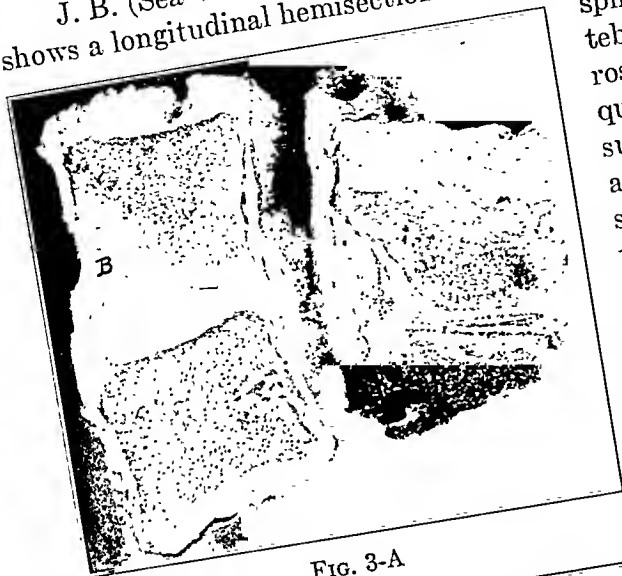


FIG. 3-A

The gross specimen (Fig. 3-A) split surface. The upper vertebral body shows dense sclerosis at the lower anterior quarter, due to a loss of blood supply. The sclerosis follows a pattern occasioned by the stripping of soft tissues and their blood vessels away from the bone. This same vertebral body shows some sclerosis at its posterior margin, where the soft tissue and periosteum have been raised by an abscess. This specimen shows an early sclerotic lesion.

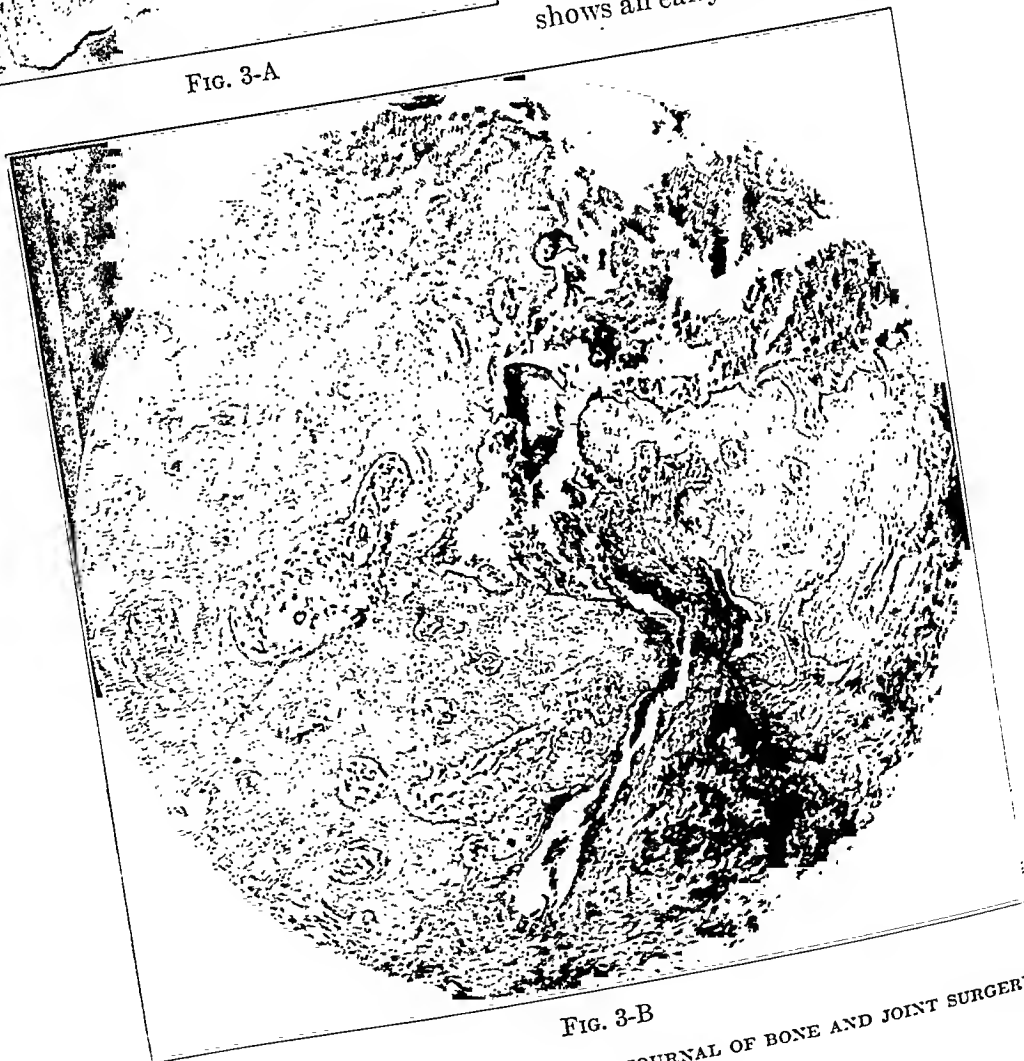


FIG. 3-B



FIG. 3-C



FIG. 3-D

The photomicrograph of bone taken from the large sclerotic area (Fig. 3-B) shows marked necrosis of bone, with increased calcification and little or no fragmentation. This is the appearance of aseptic necrosis of bone, rather than of inflammatory change,—a sclerosing process.

The anteroposterior and lateral roentgenograms of the two vertebrae taken while the patient was alive (Figs. 3-C and 3-D) show no evidence of pathology in the vertebrae or intervertebral disc.

The roentgenogram of the washed specimen (Fig. 3-E) shows very definite sclerosis of the anterior inferior portion of the upper vertebra.

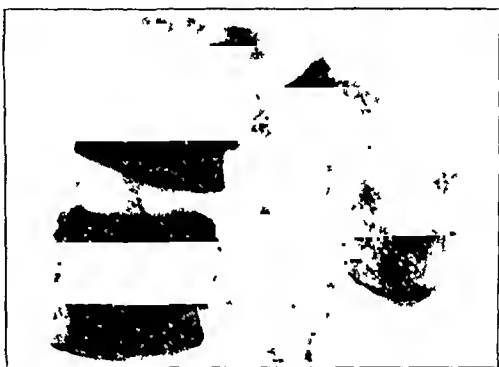


FIG. 3-E

Specimen No. 15.

A. G. (Sea View Hospital No. 8351). The gross specimen (Fig. 4-A) shows three and a half vertebrae split longitudinally. There is a typical dissecting abscess anterior to two vertebral bodies and the intervening intervertebral disc. Both vertebrae show destructive changes due to infection, and sclerotic changes due to the loss of blood supply. The intervertebral disc is in part destroyed, having formed a portion of the abscess which invaded it from the soft tissues and perichondrium at the front.

The photomicrograph of the soft tissue (Fig. 4-B) shows the fibrous-tissue wall of the abscess, with round-cell infiltration, a giant cell, and caseous necrotic material.

The photomicrograph of bone (Fig. 4-C) shows sclerosis of bone, round-cell infiltration, and necrosis of bone. This lesion represents a composite picture of changes due to destructive infection, caseation, and sclerosis caused by a loss of blood supply.



FIG. 4-B

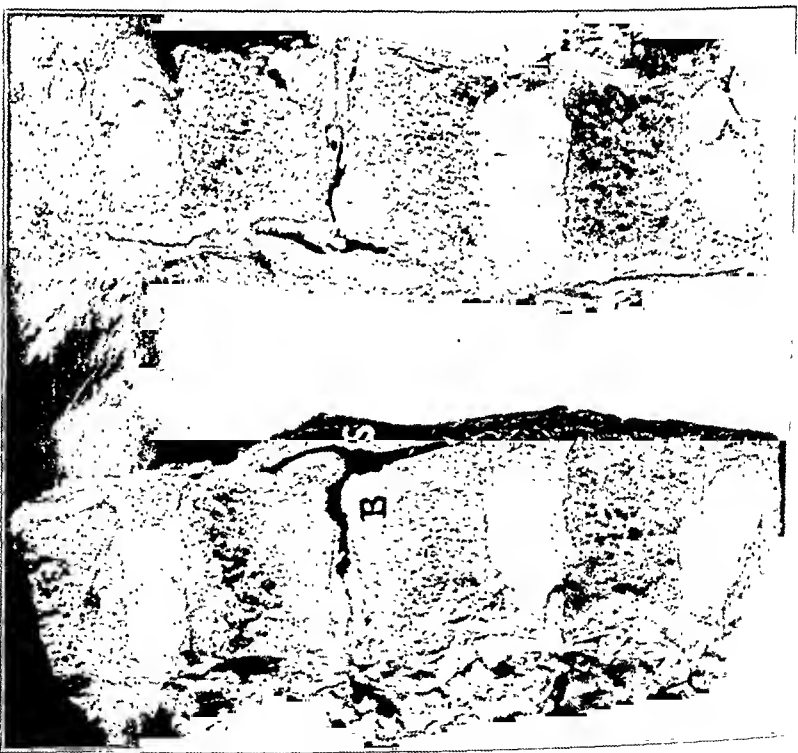


FIG. 4-A

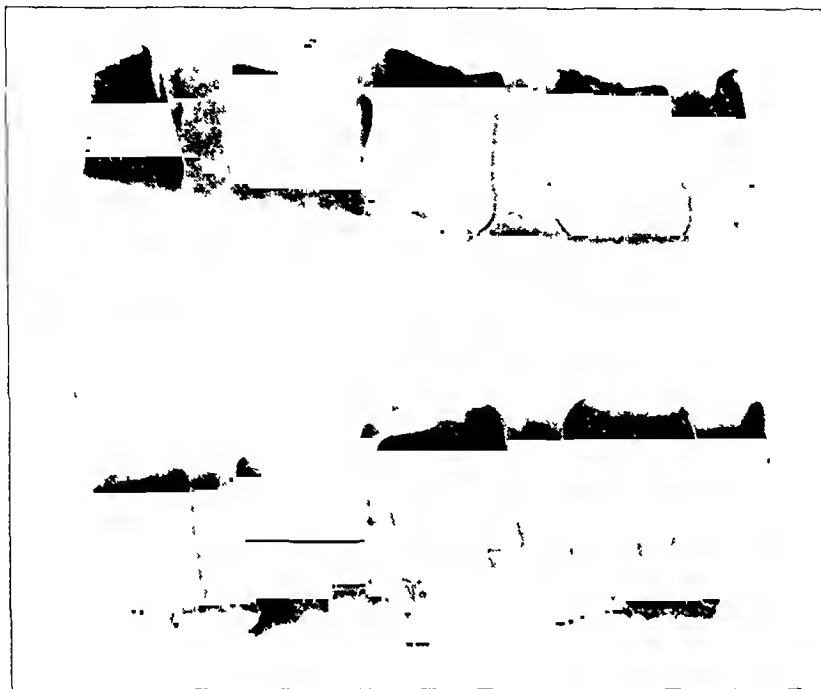


FIG. 4-D



FIG. 4-C

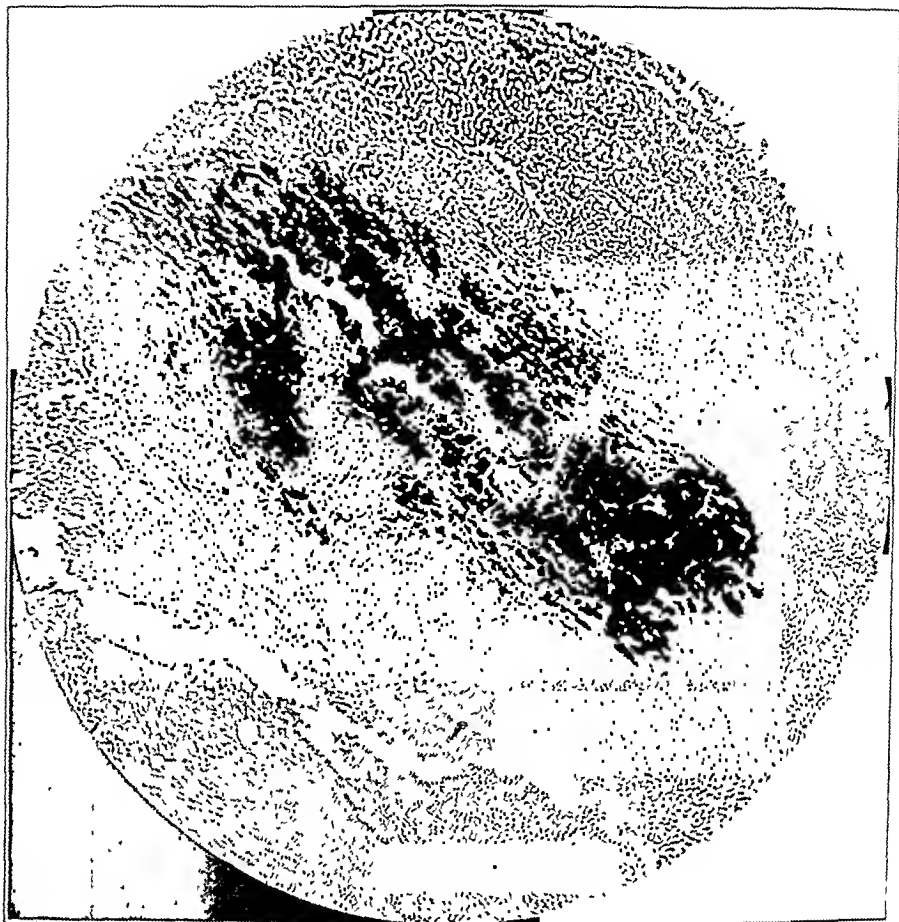


Fig. 5-B



Fig. 5-A

The roentgenograms of the washed specimen (Fig. 4-D) show beyond question destructive and sclerotic changes in the two vertebrae and the intervening disc.

Specimen No. 10.

R. S. (Sea View Hospital No. 2797). The gross specimen (Fig. 5-A) shows a longitudinal hemisection of three and one-half vertebral bodies and the intervertebral discs. There is caseous involvement of a vertebral body, which is probably secondary to a lesion in the soft tissues on the anterior border of that body. Surrounding this zone of caseation, there is an area of sclerosis due to loss of blood supply resulting from the abscess surrounding the vertebral body and also from the large abscess within the body. Sclerosis of the posterior aspect of the vertebral body should be noted. The vertebral body below also shows an advanced caseous lesion.

The photomicrograph of the soft tissue (Fig. 5-B) shows caseous necrotic debris with secondary calcium deposit,—a calcified abscess.

The photomicrograph of the bone (Fig. 5-C), which was taken adjacent to the caseous area, shows degenerating and fragmenting bone,

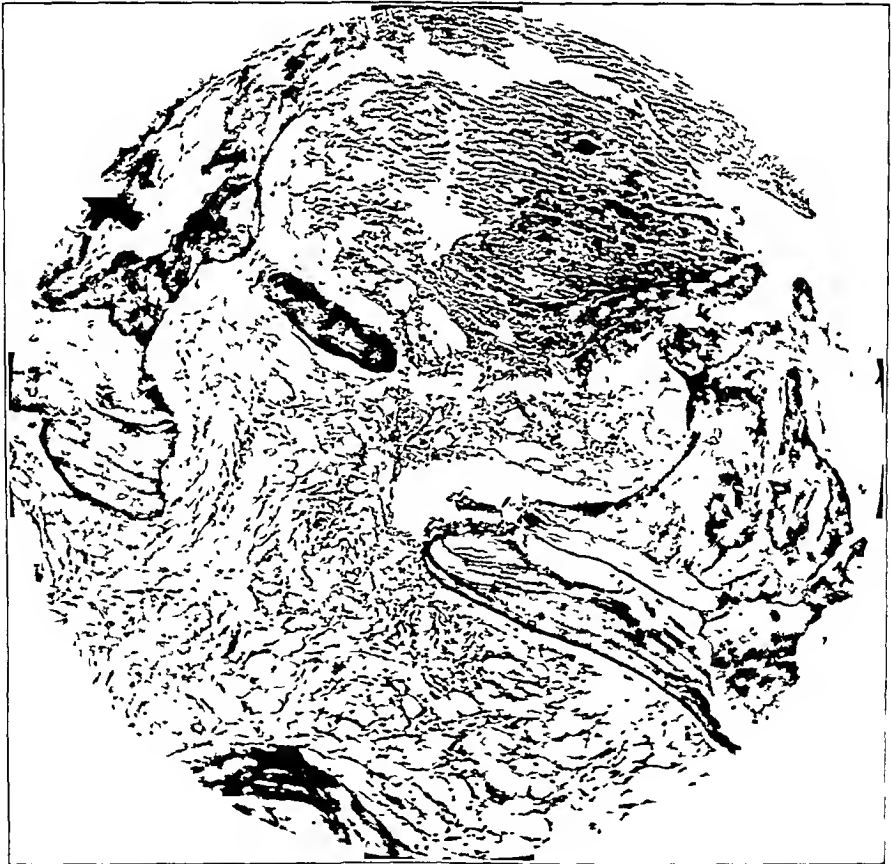


FIG. 5-C

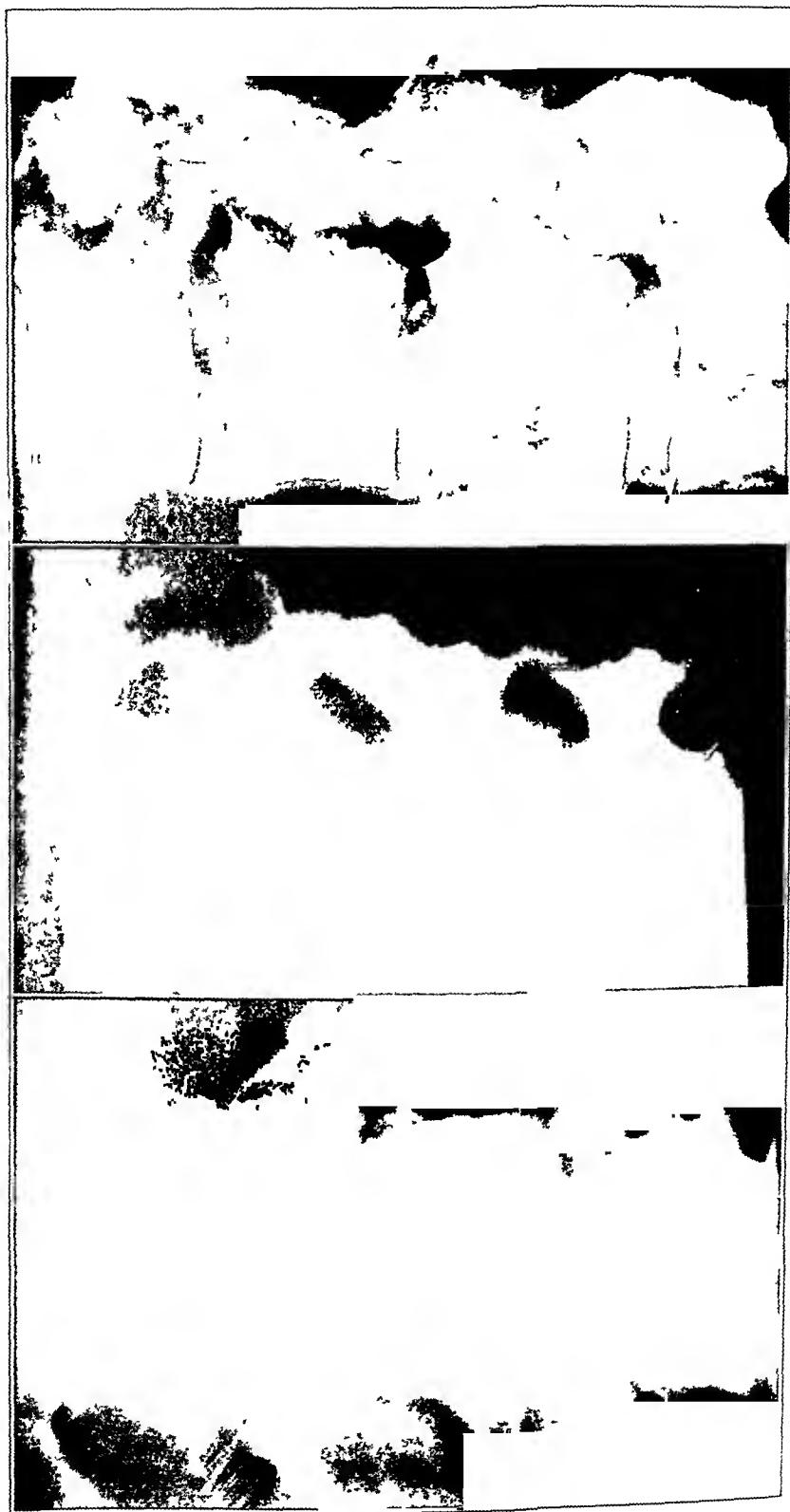


FIG. 5-F

FIG. 5-E

FIG. 5-D

with granulation tissue and necrosis in the marrow. This specimen shows a combination of both caseation and sclerosis.

The roentgenograms taken before death (Figs. 5-D and 5-E) show wide intervertebral spaces and no abscess shadow. On very careful scrutiny slight decalcification and sclerosis may be noted in the intermediate vertebral body, the first lumbar vertebra, and perhaps in the second lumbar. This escaped notice in the living patient.

The roentgenogram of the split and washed specimen (Fig. 5-F) shows the marked erosion or destruction of the bodies of the first and second lumbar vertebrae, with some increased density of the first lumbar.

Specimen No. 23.

J. S. (Sea View Hospital No. 11322). The gross specimen (Fig. 6-A) shows a longitudinal hemisection of parts of eight vertebrae from the lower thoracic and lumbar spine. Multiple sclerotic areas may be noted in several vertebral bodies with destructive changes and abscesses; the abscesses have surrounded some of the vertebral bodies depriving them of their blood supply. The picture is complicated by a spine fusion extending over the upper four full vertebrae. This was an inadequate fusion because at the time it was done the extent of the disease could not be determined by roentgenogram. The fusion has stabilized these vertebrae and has been responsible for the partial arrest of the disease in some of these bodies. It is, however, acting as a lever to further compress the unprotected and diseased area of the spine below. The sclerotic and productive bone changes are tending to obliterate the gap left by the disc which has sloughed between the third and fourth vertebrae from above downward. These changes have already caused the union of the remnant of the fifth body to the fourth.

One photomicrograph of the soft tissue (Fig. 6-B) shows a large vessel



FIG. 6-A

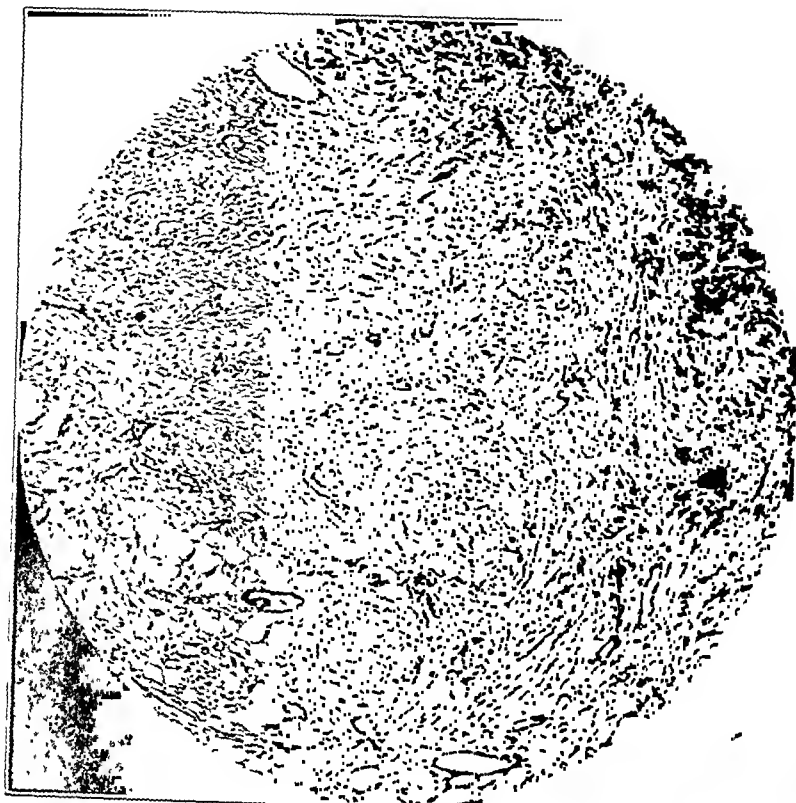


Fig. 6-C

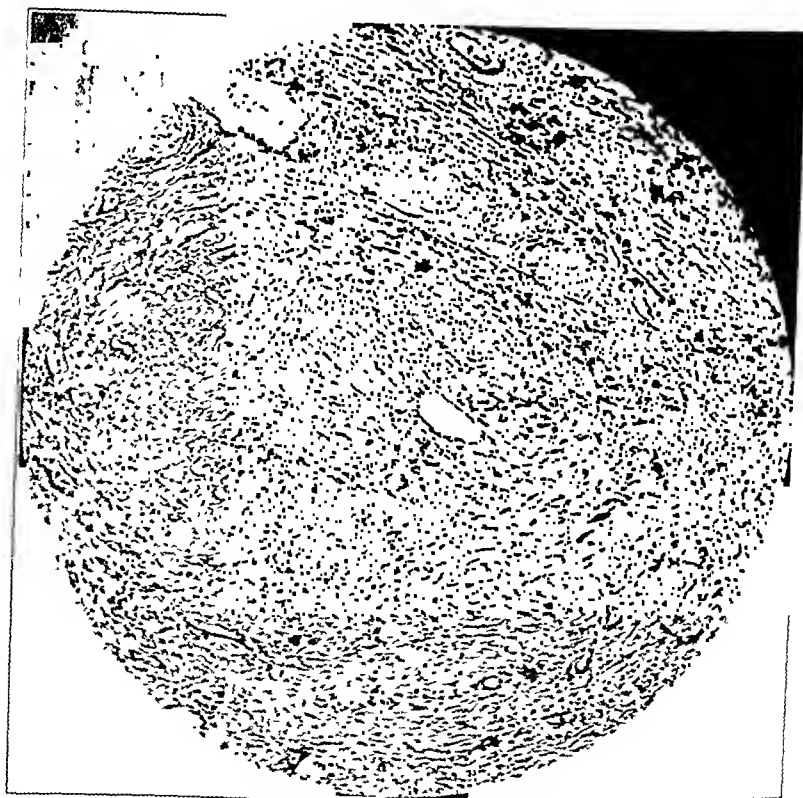


Fig. 6-B



FIG. 6-D

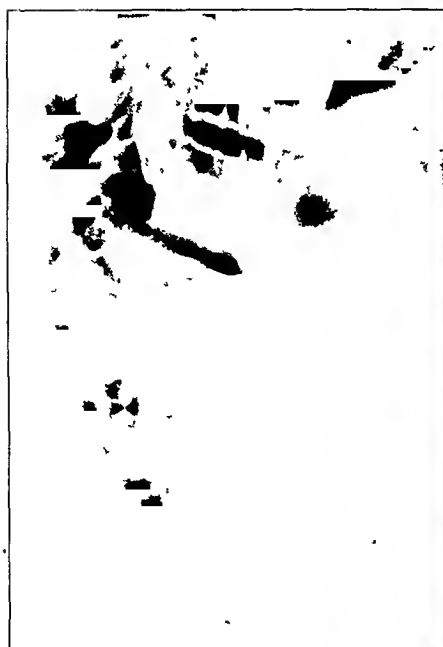


FIG. 6-E



FIG. 6-F

which has been thrombosed, recanalized, thrombosed again, and once more recanalized. In another area (Fig. 6-C) there are two smaller vessels (eight and nine o'clock positions), one of which has been completely obliterated by endarteritis; the other vessel still shows a small lumen but with marked endarteritis.

The photomicrograph of bone (Fig. 6-D) shows granular necrosis with inflammatory changes and some old-bone formation. The appearance is more that of aseptic necrosis due to loss of blood supply, than of inflammatory change.

The lateral roentgenogram taken during life (Fig. 6-E) shows a marked destructive and sclerotic lesion involving three vertebrae, with a thin joint space above those vertebrae. This is a typical roentgenogram of an advanced lesion of the spine due to tuberculosis.

The lateral roentgenogram of the washed specimen (Fig. 6-F) shows the same condition with the sclerotic and destructive changes accentuated. The extent of the spine fusion can be readily seen.

SUMMARY

1. Two pathological processes have been encountered in the human spine due to tuberculosis: first, caseation of bone and soft tissue—a destructive lesion due directly to the infection—and, second, sclerosis of bone, which, it is believed, is a vascular phenomenon occasioned by loss of blood supply from thrombosis or endarteritis, or occlusion or destruction of blood vessels by the presence of large dissecting abscesses.

2. The roentgenogram will often fail to reveal the presence of tuberculosis of the spine, and will never reveal the full extent of the damage due to the disease.

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ORTHOPAEDIC TREATMENT OF HYPERTROPHIC ARTHRITIS OF THE HIP *

BY JOHN G. KUHN, M.D., BOSTON, MASSACHUSETTS

From the Robert Breck Brigham Hospital, Boston

This paper is a study of 183 patients—eighty-six men and ninety-seven women—who were treated on the wards of the Robert Breck Brigham Hospital, before January 1941, for disabilities resulting from hypertrophic arthritis of the hip joint. In 114 patients both hips were involved and in sixty-nine one hip only was involved. The average age of the entire group at admission was 52.7 years. The age distribution was about the same for patients with both unilateral and bilateral involvement of the hip (Table I). This study of the results of conservative treatment was prompted by the infrequent mention of non-surgical treatment of this

TABLE I
AGE DISTRIBUTION OF 183 PATIENTS
(In Years)

No. of Hips	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80
One.....	1	2	7	10	11	12	18	4	2	2
Two.....		5	5	6	18	24	26	21	6	3
Totals	1	7	12	16	29	36	44	25	8	5

condition in medical literature during the past ten years. From the published reports one would be led to believe that surgery was the only effective therapy for this disability.

The causes of hypertrophic arthritis are not clearly understood, but all investigators of this problem are agreed that it is partially an ageing or wearing out of joints¹. In addition to this senescence of the joints, there have been postulated other factors—mechanical¹, biochemical², and circulatory³—which lead to more rapid changes within the joint. It has been observed that the articular changes progress more rapidly when strain and stress come upon the joint in an excessive amount or in an abnormal position of use.

With this imperfect knowledge of the etiology of hypertrophic arthritis, attempts at treatment must of necessity be directed chiefly against those physical factors which are known to lead to more rapid progression

* Read at the Annual Meeting of The American Academy of Orthopaedic Surgeons at Atlantic City, New Jersey, January 15, 1942.



FIG. 1

Roentgenogram of patient with early hypertrophic arthritis of the hip. There is increased forward inclination of the pelvis and weight is borne upon the posterior aspect of the acetabulum and the anterior surface of the femoral head.

in the articular surfaces, and there is an impairment of muscle action⁴. This is followed by articular irritation and by strain of muscles and ligaments (Fig. 1).

Muscle action becomes less efficient both for locomotion and for the stability of the hip joint, with the increased forward inclination of the pelvis which is always found in hypertrophic arthritis of the hip. After this condition has once begun, weakness develops in the musculature about the hip, particularly in the gluteus medius. Flexion of the hip is followed by adduction and by external rotation. Ligament strain occurs and is accompanied by osteocartilaginous proliferation about the hip.

An early roentgenographic diagnosis is usually not possible. The process is usually present for a number of years before symptoms appear¹⁰. The earliest roentgenographic change observed is an increased density in the posterosuperior margin of the acetabulum and the anterosuperior surface of the femoral head (Fig. 2). While there is always measurable limitation of motion in the hip joint when this is present, there are often

of the disturbance. Strains can be treated by rest, by protection of the joint, and by changing weight stresses through realignment of the whole body. Obesity can frequently be lessened by proper dietary measures. A change of occupation to less strenuous work is occasionally indicated⁵. Anatomical malformations about the hip joint can be modified only by surgical intervention, but their effects upon the body can frequently be lessened by the development of correct body mechanics.

At the hip joint, the weight of the body is borne normally by the central portion of the femoral head in contact with the strong and superior portion of the acetabulum. Whenever this is not the position of use, either from anatomical changes in the femoral head and acetabulum, or from an increased forward inclination of the pelvis accompanying faulty body mechanics, a disalignment results



FIG. 2

Roentgenogram showing early hypertrophic arthritis of the right hip. There is increased density in the upper portion of the femoral head and the superior margin of the acetabulum.

no subjective symptoms. These early roentgenographic changes are followed by osseous proliferation around the posterior edge of the acetabulum, and about the anterior side of the femoral head and neck. Later there is deformation of the femoral head and bone proliferation at the attachments of the adductors and rotators of the hip. Hydrarthrosis, villous proliferation, and irregular growth of cartilage are not readily demonstrated in roentgenograms, although they often can produce greater disability than the evident osseous changes ⁷ (Fig. 3-A).

The chief symptoms for which the patients seek relief are pain and limitation of motion. The almost constant relief of pain following rest or fixation suggests that strain of the muscle attachments, the ligaments, and the articular capsule are the chief sources of pain. The limitation of motion varies in degree from slight limitation of adduction and external rotation to no appreciable motion in the hip joint. The patient's first awareness of disability may come with inability to cross the knee or to tie the shoes. In the severer forms of hypertrophic arthritis of the hip, the leg is constantly in flexion, adduction, and external rotation, and the patient has difficulty in sitting, and has a very awkward, shuffling gait.

Complete healing and restitution of anatomical contour do not occur with any known form of treatment. Since the cause of symptoms appears to be primarily a ligament or muscle strain, treatment should first relieve such strain and attempt to prevent its recurrence. This is

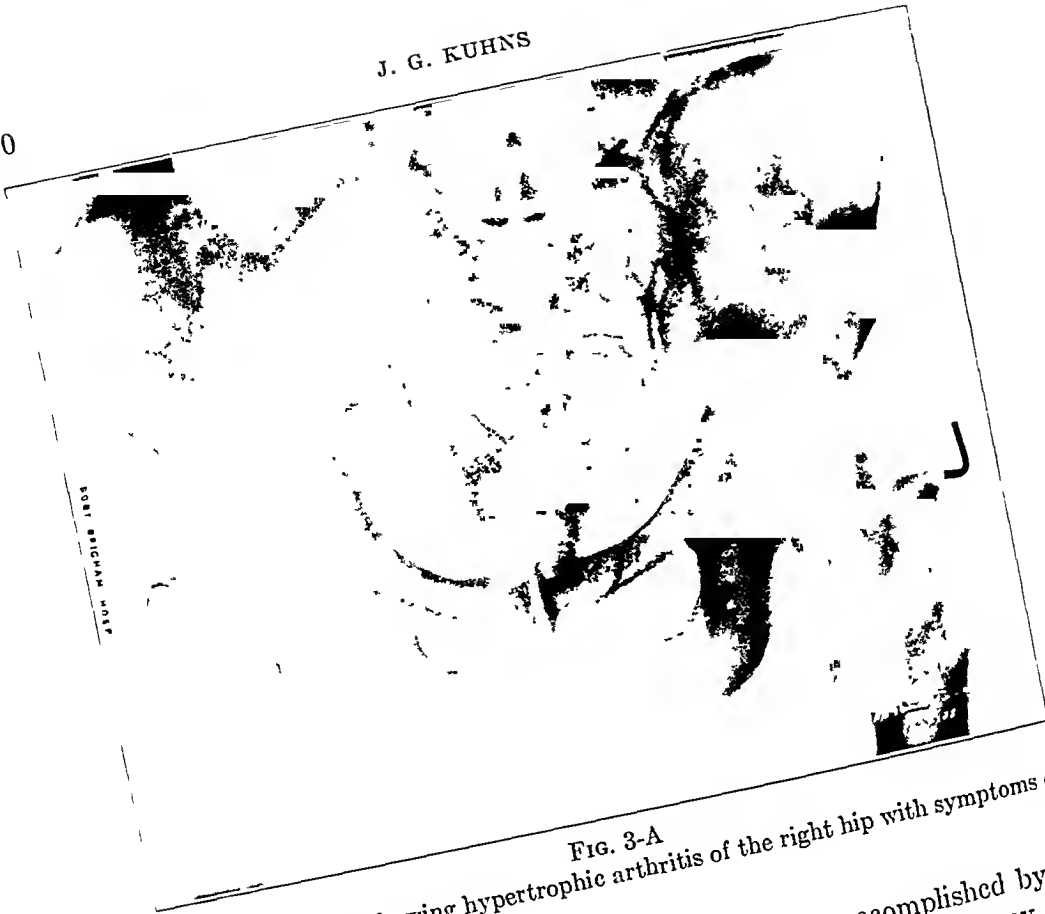


FIG. 3-A
Roentgenogram showing hypertrophic arthritis of the right hip with symptoms of twenty years' duration.

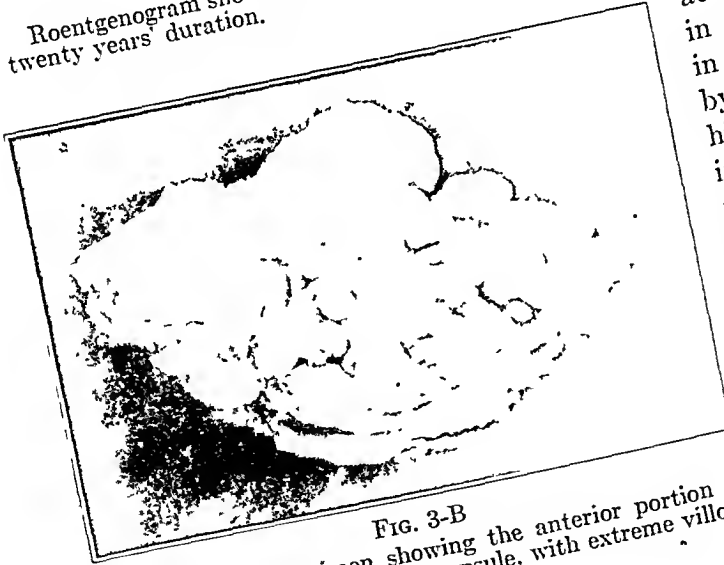


FIG. 3-B
Pathological specimen showing the anterior portion of the joint and of the articular capsule, with extreme villous formation and soft-tissue overgrowth.

accomplished by rest in recumbency, and, in the severer cases, by splinting of the hip. To secure lasting improvement in function, treatment must correct or decrease the flexion and adduction deformity of the hip. This is brought about by exercises, casts, traction, and, in rare instances, by manipulation. It must also decrease the excessive forward inclination of the pelvis and secure weight-bearing of the femur in contact with the strong, superior part of the acetabulum. This is obtained by postural exercises and by the temporary wearing of a pelvic belt. The treatment which has been used by the author, with the indications for the various procedures, is given in Table II.

TABLE II
PLAN OF TREATMENT

<i>Indications</i>	<i>Treatment</i>
Pain and muscle spasm.....	Rest in bed
Continued muscle spasm and deformity.....	Traction (skin)
Deformity and pain.....	Spica
Muscle weakness and faulty weight-bearing at the hip joint.....	Exercises for correction of body mechanics
Incomplete correction of flexion and adduction deformity, and weakness of muscles.....	Pelvic belt or special corset
Limitation of motion with little change in the femoral head.....	Manipulation
Persisting pain, particularly in the aged.....	Roentgenotherapy

On admission to the Hospital the patient was placed on a firm bed. A pillow was put under the thigh if there was much muscle spasm or flexion deformity. Heat was applied over the affected hip anteriorly and laterally for periods of thirty minutes three times a day. As soon as muscle spasm had subsided, exercises were given to decrease the lordosis of the lumbar spine and the forward inclination of the pelvis, and to lessen the flexion deformity of the hip. These exercises, performed at least twice a day, taught the patient to retract the lower abdomen and at the same time to contract the gluteal muscles. In this way deformity was gradually decreased, and the weight-thrust in walking was brought more nearly upon the superior and strong part of the acetabulum rather than upon the posterior portion. Pain usually subsided within ten days.

When symptoms did not subside quickly and there was persisting flexion and adduction deformity, a spica was applied to the hip including the entire leg. When deformity was corrected very slowly, a series of plaster spicas were sometimes required, each spica securing a little more correction of the deformity. Traction upon the hip joint was employed only in the presence of much muscle spasm with little limitation of motion. When muscle spasm and pain had subsided, the patients were allowed up for increasing periods of time with a pelvic belt or corset. This was found to be an adequate support for the prevention of further symptoms, after the patient had been taught to bear weight upon the hip joint in a better functional position. In many instances normal weight-bearing at the hip joint could not be regained, but in most of the patients sufficient improvement was obtained in the position in which the hip was used. Through this improved use of the hip joint, tendency to recurrence of the deformity was less, sprain was eliminated or greatly lessened, and pain disappeared.

While this orthopaedic treatment was being carried out, an appraisal of the general state of health was made, and such factors as obesity, endocrine disturbances, and faulty hygiene were considered. This was done to aid in maintaining the improvement gained. The average stay in the Hospital for these patients was six weeks. The ability to walk without

pain and to work often required a longer period. Occasionally maximum improvement was seen only after a number of months. When no relief of symptoms was observed after several weeks of treatment, other causes of the symptoms than the hypertrophic arthritis were usually present. Chief among these other causes were malignancy, osteitis deformans, and acute infections.

The end results of treatment, a year or more after discharge from the Hospital, are given in Table III. Those listed as working and without symptoms had no pain on walking, no noticeable deformity, and were doing their regular work. Those listed as improved had less pain than before, less deformity at the hip, and an increase in motion of 10 degrees or more. Those unimproved showed little change or became worse.

Eight patients died in the Hospital, seven have since died, and ten cannot be traced at the present time. Of the fifty-three patients who were not helped by the treatment, twenty-one were elderly individuals with extensive generalized hypertrophic arthritis and with other chronic diseases. Conservative treatment was found to be least effective in young persons with extensive malformation of the femoral head and acetabulum, particularly where this condition was present on one side only. In these individuals, surgery is the preferred form of treatment.

There are two other procedures which should be considered in the conservative treatment of hypertrophic arthritis of the hip,—manipulation of the hip joint, and roentgenotherapy. Eight of the patients who were unimproved were subjected to manipulation under anaesthesia (Table IV). This procedure is advocated only when there is not much



FIG. 4-A

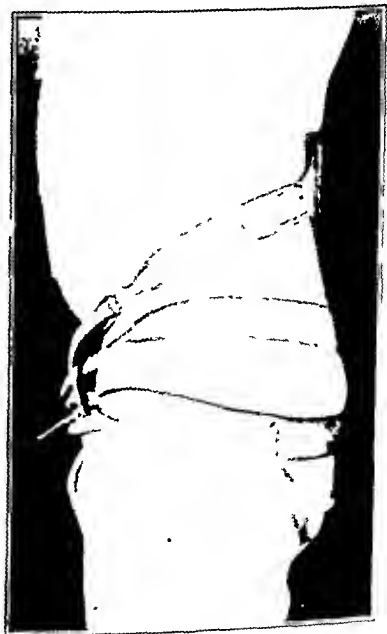


FIG. 4-B

Posterior and lateral views of the pelvic belt used in the treatment of hypertrophic arthritis of the hip.

TABLE III
END RESULTS OF TREATMENT BY REST, HEAT, AND EXERCISE

Age of Patients and Hips Involved	No. of Patients	No Symptoms. Working		Slight Symptoms. Improved		Unimproved		Died or Untraced
		No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.
Unilateral								
45 years of age or under . . .	10	1	10.0	3	30.0	6	60.0	0
Over 45 years of age	55	18	32.7	19	34.6	18	32.7	4
Bilateral								
45 years of age or under . . .	9	2	22.2	2	22.2	5	55.6	1
Over 45 years of age	84	26	30.9	34	40.5	24	28.6	20
Totals	158	47	29.8	58	36.7	53	33.5	25

TABLE IV
END RESULTS OF OTHER TREATMENT

Treatment	No. of Patients	Relieved		Partially Relieved		Unrelieved	
		No.	Per Cent.	No.	Per Cent.	No.	Per Cent.
Manipulation	8	7	87.5	0	0.0	1	12.5
Roentgenotherapy	21	16	76.2	0	0.0	5	23.8

alteration of the spherical shape of the femoral head⁶. Under such conditions the limitation of motion and the deformity are chiefly the result of muscle spasm and of contractures in the soft tissues. This limitation of motion may be improved by a gentle manipulation of the hip joint. An increased range of motion is secured by stretching contractures which have developed in the articular capsule and in the muscles, particularly the adductors. The manipulation is carried out gently, an assistant holding the pelvis; the hip is brought into acute flexion, abduction, and internal rotation. Seven of these patients were much improved by this procedure. One patient with moderate deformation of the femoral head was not benefited. The improvement in these patients has continued to the present time.

Roentgenotherapy in hypertrophic arthritis of the hip is used as a palliative measure only⁹. It does not lead to any appreciable change in

the deformity, but it frequently relieves pain, and increased motion at the hip joint is seen sometimes following its use. It is used particularly in elderly individuals with severe pain, when vigorous therapy would not be well tolerated. Roentgenotherapy has been used in twenty-one elderly persons with hypertrophic arthritis of the hip, with relief of pain in sixteen of them (Table IV).

CONCLUSIONS

The symptoms observed in the presence of hypertrophic arthritis of the hip are frequently the result of muscle and ligament strain. With the increased forward inclination of the pelvis and the flexion of the hip, weight-thrust is changed, and the function of the muscles about the hip is impaired. This leads to strain, fatigue, and instability.

The aim of orthopaedic treatment of such disability is the use of the hip in as nearly normal weight-bearing as possible. In this way recurrence or aggravation of the disability is prevented.

In 158 patients with disability from hypertrophic arthritis of the hip, forty-seven, or 29.8 per cent., were entirely relieved of their symptoms, and fifty-eight, or 36.7 per cent., were greatly improved. The least improvement was observed in those with unilateral involvement and in those with extensive flexion and adduction deformity. It is among these, particularly the latter group, that surgical therapy is sometimes required.

Manipulation of the hip often leads to improved motion, if there is little deformation of the femoral head.

Roentgenotherapy is a helpful measure to relieve pain, particularly in aged or debilitated patients.

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TRANSPLANTATION OF THE EXTENSOR TENDON FOR CORRECTION OF THE OVERLAPPING FIFTH TOE

BY PAUL W. LAPIDUS, M.D., F.A.C.S., NEW YORK, N. Y.

From the Hospital for Joint Diseases and the New York Polyclinic Medical School and Hospital,† New York*

The purpose of this paper is to present an operative procedure which has been performed in a few cases since February 1936 with satisfactory results. Although "overlapping fifth toe" is a well-known deformity, it seems to be worth analyzing in a more detailed manner. As the name itself implies, the fifth toe overlaps upon the dorsal aspect of the fourth toe. Often the congenital nature of this condition can be definitely established, and sometimes it is also hereditary. There are three main components of the deformity:

1. Adduction contracture of the fifth toe toward the fourth,
2. Dorsiflexion contracture of the fifth toe at the metatarsophalangeal joint,
3. External rotation of the fifth toe around its long axis, so that its nail faces laterally.

All these changes take place mainly at the metatarsophalangeal joint of the fifth toe. Adduction may also be present at the proximal interphalangeal joint.

In all of these cases the medial (tibial) collateral ligament, and the dorsal and medial part of the capsule of the metatarsophalangeal joint are shortened. In some cases with marked deformity, the skin surrounding the web is also contracted. Usually the extensor tendon of the fifth toe is shortened and displaced medially. The fifth toe has only one extensor tendon, supplied by the extensor digitorum longus. The extensor digitorum brevis tendon for the fifth toe is, as a rule, absent in the human foot. The whole toe often appears to be smaller, and the toe nail shorter and flatter than normal. In addition to this, the cylindrical form of the fifth toe is frequently lost; the toe appears to be flattened in the dorso-plantar direction, being paddle-shaped. The plantar surface of the paddle is not horizontal, but approaches a vertical plane, hugging the dorsolateral surface of the fourth toe.

Not infrequently people with this deformity are able to go through life wearing custom-made shoes, and engaging in occupations requiring strenuous use of their feet, without any discomfort whatsoever. The Civil-Service regulations consider a person with an overlapping fifth toe as unfit for service, and require correction before the candidate is accepted. It appears to the writer that the potential disability inherent in this deformity seems to be somewhat overestimated. Nevertheless, some individuals seek professional advice, and are willing to

* Service of Leo Mayer, M.D.

† Service of J. J. Nutt, M.D.

submit themselves to an operative correction, because of discomfort, due to pressure of the shoe, and painful corns over the dorsum of the fifth toe, or soft corns between the fourth and fifth toes; or for cosmetic reasons. A number of patients request the operation because their applications for service in the Police or Fire Department have been rejected.

In one of the author's cases, a girl eight and one-half years old (not operated upon), the overlapping fifth toe was on the side of a mild transient hemiplegia following birth injury (breech presentation).

Another patient, a young woman, twenty-three years old, with fairly well-corrected congenital club feet (worse on the right side) presented marked overlapping of the left fifth toe. The paternal grandfather of this patient was said to have a similar deformity of the fifth toe. Operative correction of the left fifth toe with satisfactory result was performed in this case on February 28, 1936. (The patient was last seen on May 5, 1939.)

Conservative treatment consists of padding and the application of salicylic-acid ointment (30 to 50 per cent.) for removal of painful corns, in addition to a shoe allowing adequate room for the fifth toe.

The operative approach which is offered is devised to correct the three components of the deformity, that is:

1. To abduct the toe,
2. To flex it plantarly,
3. To rotate it internally.

DESCRIPTION OF OPERATION

The skin of the foot is prepared with Whitfield's ointment for at least one week before the operation. No tourniquet is used. A local block anaesthesia over the level of the fifth metatarsal base is given, with no novocain solution being injected at the operative field. A longitudinal hockey-stick incision (Fig. 1-A) is made along the dorsomedial border of the fifth toe, starting from the region of the distal interphalangeal joint and running proximally to the web between the fourth and fifth toes. From here the hook of the hockey stick is added by running the incision over the dorsum of the fifth metatarsophalangeal joint laterally, and in a proximal direction to the lateral aspect of the fifth metatarsal head. The skin over this region is rather thin, and care should be taken not to cut the underlying aponeurotic expansion of the extensor tendon. The extensor tendon is carefully dissected without damaging its insertion. The fifth toe is flexed plantarly, so that its extensor longus tendon becomes taut and projects beneath the skin. A transverse incision about one centimeter long is then made over the prominent tendon at the level approximately corresponding to the middle of the fifth metatarsal bone. The extensor longus tendon of the fifth toe is identified by moving the toe. It is cut transversely, and its free distal stump gently pulled out into the wound over the fifth toe (Fig. 1-B). The tendon is then completely freed and followed to its insertion into the nail phalanx. Special care should be

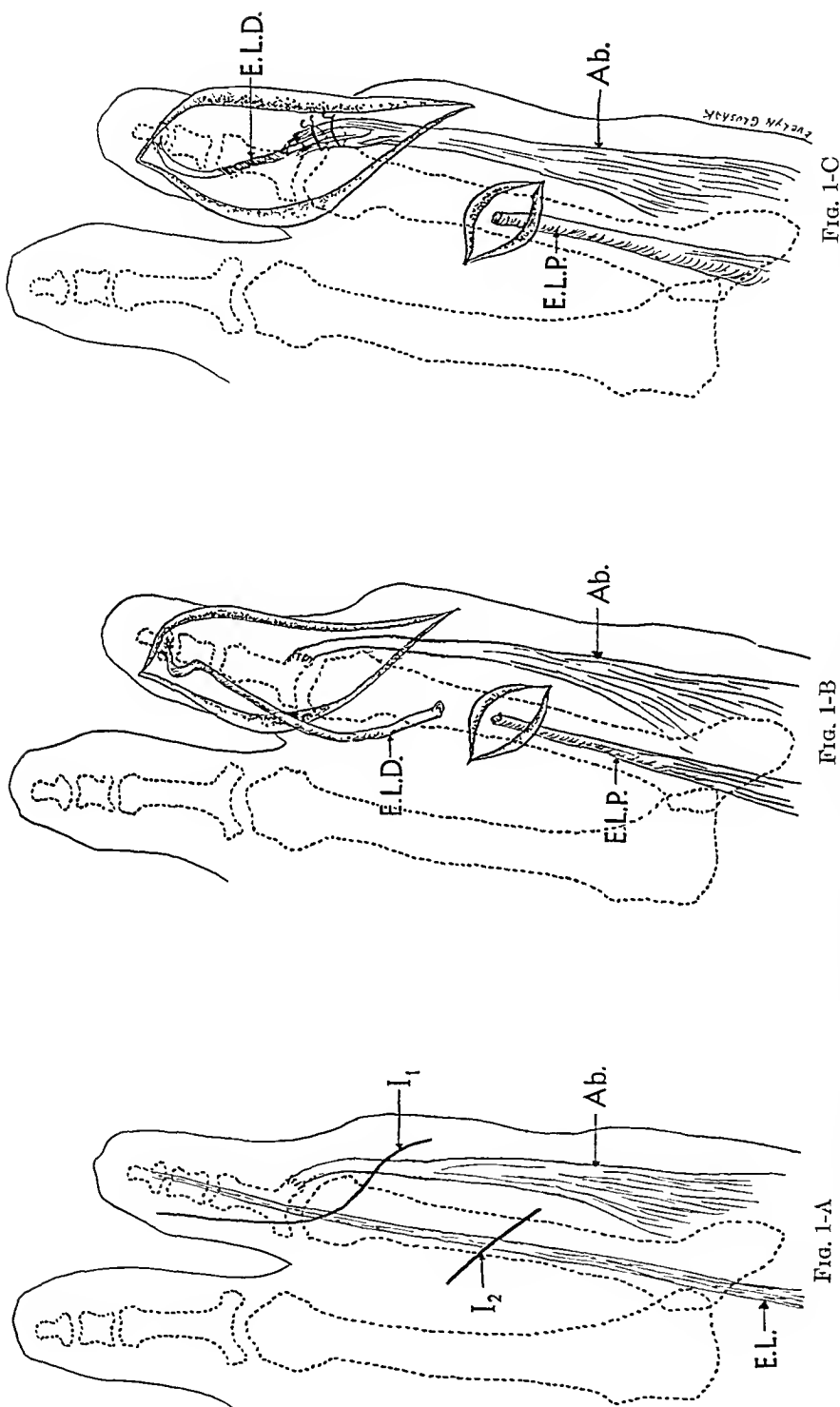


FIG. 1-A

FIG. 1-B

FIG. 1-C

Schematic drawings of the operative procedure showing the dorsal view of the fourth and fifth toes.

Fig. 1-A: I_1 and I_2 represent the two skin incisions; *E.L.*, the extensor longus tendon; *Ab.*, the abductor digiti quinti.

Fig. 1-B: *E.L.D.* represents the distal stump of the extensor longus tendon, which was pulled out into the wound over the fifth toe; *E.L.P.*, the proximal stump of the extensor longus tendon.

Fig. 1-C: The distal stump of the extensor longus tendon (*E.L.D.*) is translocated medially and plantarily (plantar part is crossed transversely), and its end is sutured into a slot made in the tendon of the abductor digiti quinti (*Ab.*).

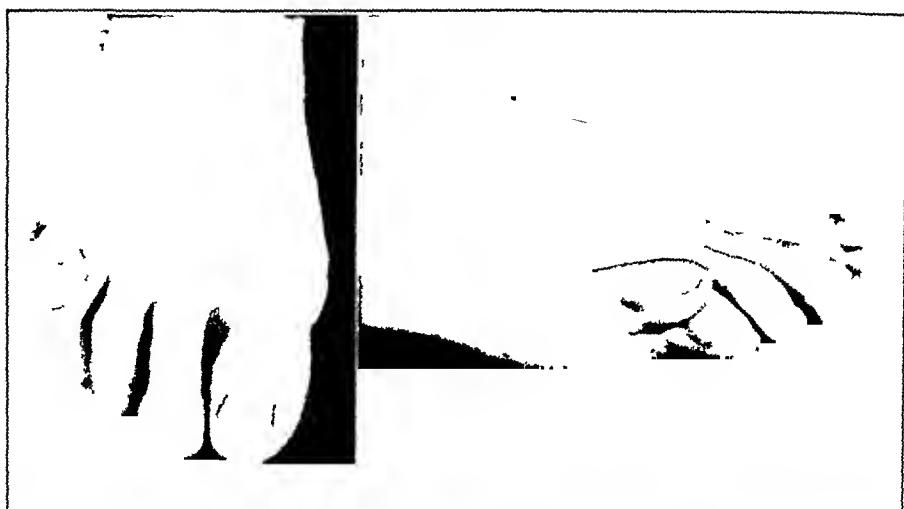


FIG. 2-A

FIG. 2-B

Overlapping congenital right fifth toe in a girl, ten years old.



FIG. 2-C

FIG. 2-D

Both feet, of the same patient as shown in Figs. 2-A and 2-B, one year after the operation (performed on April 26, 1939), showing the normal appearance of the right fifth toe. Note also the mild deformity of the left fifth toe (Fig. 2-C) which was not operated upon.

exercised to preserve the tendinous insertion. The capsule of the fifth metatarsophalangeal joint is exposed bluntly, and cut transversely on its dorsal and medial aspect where it is usually contracted. This capsulotomy should be thoroughly performed, so that afterward the dorsiflexion and adduction deformity of the fifth toe is entirely corrected, and remains so without any external support. An oblique subcutaneous channel is then prepared with a blunt instrument. This channel starts near the distal interphalangeal joint on the dorsomedial aspect of the toe, and

winds around its plantar surface in a proximal and lateral direction, emerging on the plantar lateral aspect of the fifth metatarsophalangeal joint. The tendon of the extensor of the fifth toe is now passed through the channel so that it encircles the plantar surface of the fifth toe in an oblique spiral fashion. The conjoined tendon of the abductor and the short flexor of the fifth toe is then split longitudinally, and the free end of the translocated extensor tendon is buried and sutured to the conjoined tendon (Fig. 1-C). Some tension is put on the transplanted extensor tendon, and all the three components of the deformity of the fifth toe are slightly overcorrected while the tendon is sutured. The skin is then loosely united with interrupted stitches. In marked cases with extensive skin contracture, it is sometimes necessary to shift the opposite edges of the skin against each other before suturing them, or even to do some additional plastic surgery to compensate for the insufficiency of the skin. The toe is immobilized by means of a short, steel, corset splint which can be molded to the required shape. Extreme gentleness and a completely atraumatic technique will insure proper healing.

AFTER-TREATMENT

The circulation of the toe, of course, must be carefully supervised. In order to allow for postoperative swelling, the splint should not be too tightly strapped to the toe. Adequate correction must be obtained by the surgical procedure, and not by the subsequent splinting. The only purpose of immobilization is to maintain the correction until healing takes place. At the end of a week, the dressing is changed and the splint is reapplied (for about three or four weeks), and the patient may be allowed out of bed with a shoe cut out over the fifth toe.

The results in a few cases have been quite satisfactory, so that the author feels justified in offering the above procedure for general use.

Disarticulation of the fifth toe must be warned against. In at least two cases (operated upon by another surgeon and followed by the author) the results were very discouraging. A painful steplike prominence of the fifth metatarsal head was more disabling than the original deformity.

SUMMARY

An operative procedure for correction of overlapping fifth toe consists in running the distal stump of the extensor longus tendon, with its insertion intact, through an oblique spiral channel across the plantar surface of the toe, and implanting it into the conjoined tendon of the abductor and short flexor of the fifth toe, after dorsal and medial capsulotomy of the fifth metatarsophalangeal joint. The operative procedure seems to be mechanically sound, because it not only corrects the main three components of the deformity, but also utilizes the muscle power of the abductor and short flexor for active maintenance of the correction.

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FRACTURES AND FRACTURE-DISLOCATIONS OF THE ASTRAGALUS (TALUS)*

BY ROBERT D. SCHROCK, M.D., HERMAN F. JOHNSON, M.D., AND CHESTER H. WATERS, JR., M.D., OMAHA, NEBRASKA

From the Department of Orthopaedic Surgery, University of Nebraska College of Medicine, Omaha

The marked dysfunction secondary to injuries of the astragalus (talus) demands further study and correlation of opinions if we are to conserve better function. As shown in an analysis of tarsal fractures by Shands in 1931, fractures and dislocations of the astragalus comprise approximately one-third, and fractures of the os calcis about one-half of the injuries to the tarsal bones. Many reports have been made of individual cases of this disabling lesion, but few of the study of collected cases of fractures and fracture-dislocations of the astragalus.

In 1906 in Toronto under the Presidency of B. E. McKenzie, M.D., Ely presented to The American Orthopaedic Association, "Old Fracture of the Tarsus: With a Report of Seventeen Cases", five of which were fractures of the astragalus. At that time, Ely lamented the inaccuracy of diagnosis in these injuries. He lamented also the tremendous disability subsequent to the complicated fractures of the astragalus. With improvement in diagnostic facilities, the former lamentation has been well answered. Errors in detailed diagnosis are now infrequent. Effective therapy has not kept pace, however, with the increased accuracy of diagnosis.

Sneed of New York reported, in 1925, the first reduction and retention of a dislocated astragalus. The retention of the astragalus was against his better judgment. He presented at that time a study on the circulation of the astragalus.

In 1929, Graham and Faulkner reported a series of ten astragalectomies in patients with fractures of the astragalus, but these cases had been seen late. Of these feet, five were stable and painless; the results in two were fairly good, and in three were disappointing.

In 1932, Phemister presented, "Transplantation of the Astragalus and Demonstration of Aseptic Necrosis".

In 1939, McKeever of Los Angeles in an excellent thesis, as yet unpublished, reported a study of eighteen cases of fracture of the neck and body of the astragalus, with follow-up from nine months to eleven years. He made a splendid study of the blood supply to the astragalus, demonstrating that the "entire vascular supply of the astragalus is derived from branches of the anterior tibial artery. There is evidence also, that the artery, which eventually breaks up into several nutrient arteries, is carried in the dense superior astragalocephoid ligament, which extends as a broad band from the dorsal surface of the neck of the astragalus to the dorsal

* Presented at the Annual Meeting of The American Orthopaedic Association, Toronto, Ontario, June 11, 1941.

periphery of the scaphoid. In this ligament, the artery divides into several (two to four) smaller arteries which perforate the supermedial aspect of the neck of the astragalus, where foraminae are clearly present.

"No evidence of arteries perforating either the posterior or anterior calcaneo-astragaloid ligament or from the internal calcaneo-astragaloid ligament in the subastragalar joints was apparent. In no instance was it possible to demonstrate arteries throughout the body of the astragalus."

In seventeen of McKeever's cases, varying degrees of aseptic necrosis were evident.

Speed and Smith in 1939 set forth dependable generalizations with reference to fractures and dislocations of the astragalus.

Again in 1939, Miller and Baker presented a detailed analysis of thirty cases of fracture-dislocation of the astragalus. They advocate certain definite procedures, and in conclusion they state:

"1. Treat simple fractures of the astragalus simply. . . .

"2. Do early accurate open reductions on fractures of the astragalus when there is displacement of fragments or derangement of the articular surfaces. When entirely satisfactory reduction cannot be obtained, subastragalar [triple] arthrodesis should be considered as an early measure. Panarthrodesis is sometimes necessary."

Miller and Baker advocate, in those cases where subastragalar arthrodesis is indicated, that calcaneocuboid arthrodesis and astragaloscaphoid arthrodesis be added. (If the cartilage surfaces of these two joints are relatively intact, the present authors feel that the triple arthrodesis should not be done, but that mobility should be retained in both the calcaneocuboid and astragaloscaphoid joints.) Miller and Baker continue:

"3. After closed or open reductions, do arthrodesing operations if painful joints develop.

"4. Do not do astragalectomies except in the presence of frank infections."

In the series of cases presented herewith (Table I) there were ten astragalectomies.

The technique of astragalectomy as devised by Royal Whitman for paralytic calcaneovalgus has been applied directly to astragalectomy where the pathology is traumatic. It is evident the two conditions are not comparable. In the paralytic calcaneovalgus foot, the muscle support is unbalanced with major weakness in the plantar flexors and adductors of the foot. In fractures of the astragalus, the musculature is intact and retains its physiological balance. Mobility of the mid-tarsal joints should be retained.

Where astragalectomy is essential because of trauma, better function is obtained by maintaining the foot forward where the anterior margin of the tibia is in the vertical plane with the calcaneocuboid joint. The redundant soft parts normally about the neck and head of the astragalus will then give a soft-part buffer between the tibia and the scaphoid. Greater mobility of the mid-foot is maintained.

From the series of thirty cases of fracture and fracture-dislocation of the astragalus, seven representative case reports are given in detail.



FIG. 1-A

Case 1. B. C. November 29, 1933. Fracture of the neck of the right astragalus.

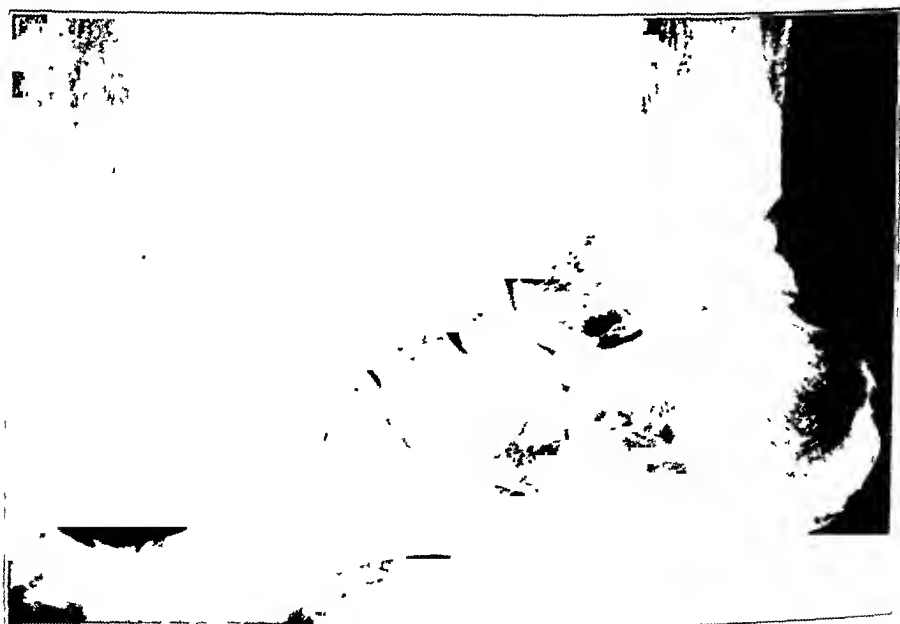


FIG. 1-B

Case 1. B. C. May 9, 1941. Moderate sclerosis of the body eight years after injury. There are no arthritic changes; function is excellent.

CASE 1. B. C. A male, thirty-four years old, suffered a displaced fracture through the base of the neck of the right astragalus and a chip fracture of the body of the left astragalus, from a fifteen-foot fall, November 29, 1933 (Fig. 1-A). The fracture of the right astragalus was reduced by manipulation, and was immobilized in a plaster boot for ten weeks. The undisplaced fracture of the left astragalus was treated by simple immobilization in plaster for six weeks. The end result, as determined April 25, 1941, is considered excellent; the patient was walking without any limp and was working ten hours daily as a carpenter.

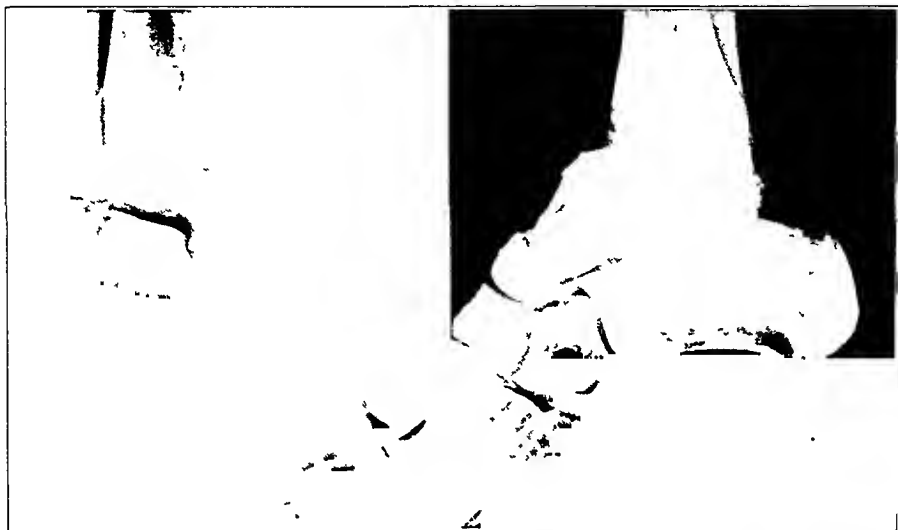


FIG. 2-A

Case 2. D. D. March 31, 1940. Horizontal fracture through the body of the right astragalus.



FIG. 2-B

Case 2. D. D. April 26, 1941. Union is complete with only slight sclerosis of the body and irregularity of the dome. Perfect functional result.

CASE 2. D. D. A boy, fourteen years old, fell from a cliff March 31, 1940, sustaining a horizontal fracture through the body of the right astragalus with medial displacement (Fig. 2-A). The fracture was reduced by manipulation, and was immobilized in a plaster boot for eight weeks. End result May 11, 1941, showed no limp, pain, or disability.

CASE 3. J. J. S. A man, aged forty-five, sustained a linear fracture through the body of the left astragalus from a severe twisting injury to the left ankle January 20, 1940

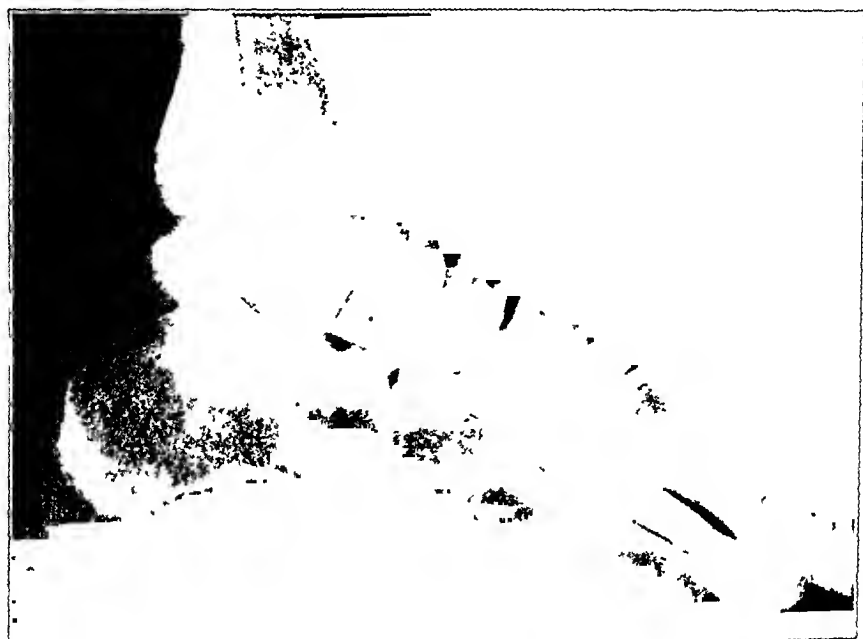


FIG. 3-A

Case 3. J. J. S. January 20, 1940. Vertical fracture through the body of the left astragalus.



FIG. 3-B

Case 3. J. J. S. January 22, 1940. Reduction with fixation by metal pin.

(Fig. 3-A). Open reduction with internal fixation was performed after forty-eight hours (Fig. 3-B) and the ankle was immobilized in plaster for nine weeks. Examination May 11, 1941, showed the patient walking with a slight limp, and having some limitation of ankle and subastragalar motions. He had some pain, but was working full time as a salesman. The end result is considered fair to good.



FIG. 3-C

Case 3. J. J. S. April 29, 1941. Appearance fifteen months after injury, showing some flattening of the dome of the astragalus and narrowing of the joint space. Function is fair.



FIG. 4-A

Case 4. M. M. April 21, 1925. Severely comminuted fracture-dislocation of the right astragalus.

CASE 4. M. M. A girl, twenty years old, sustained a markedly comminuted simple fracture-dislocation of the right astragalus when struck by a car, April 21, 1925 (Fig. 4-A). Astragalectomy with temporary internal fixation was performed May 6, 1925 (Fig. 4-B). The end result, in May 1941, showed that the patient had developed a marked equinus, although she walked without limp or pain in moderately high-heeled shoes (Fig. 4-C). This case illustrates the fact that in the non-paralytic foot, where astragalectomy is performed, the posterior displacement of the foot should not be carried to the extreme.

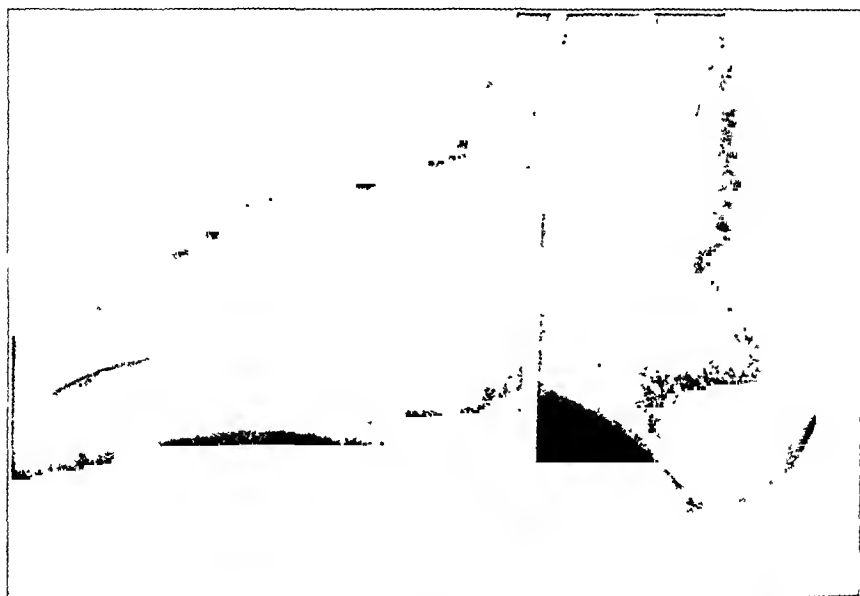


FIG. 4-B

Case 4. M. M. June 22, 1925. Two months following astragalectomy and fixation with steel pin.



FIG. 4-C

Case 4. M. M. May 3, 1941. Exaggerated equinus position sixteen years after injury. There is excellent, painless function.

CASE 5. P. A. A man, thirty-one years old, suffered an astragaloscaphoid dislocation on the right in a car accident, December 11, 1938 (Fig. 5-A). Reduction was performed twenty-four hours later and maintained by plaster fixation for three weeks. In February 1939, examination showed normal, painless motion.



FIG. 5-A

Case 5. P. A. December 11, 1938. Astragaloscaphoid dislocation on the right.

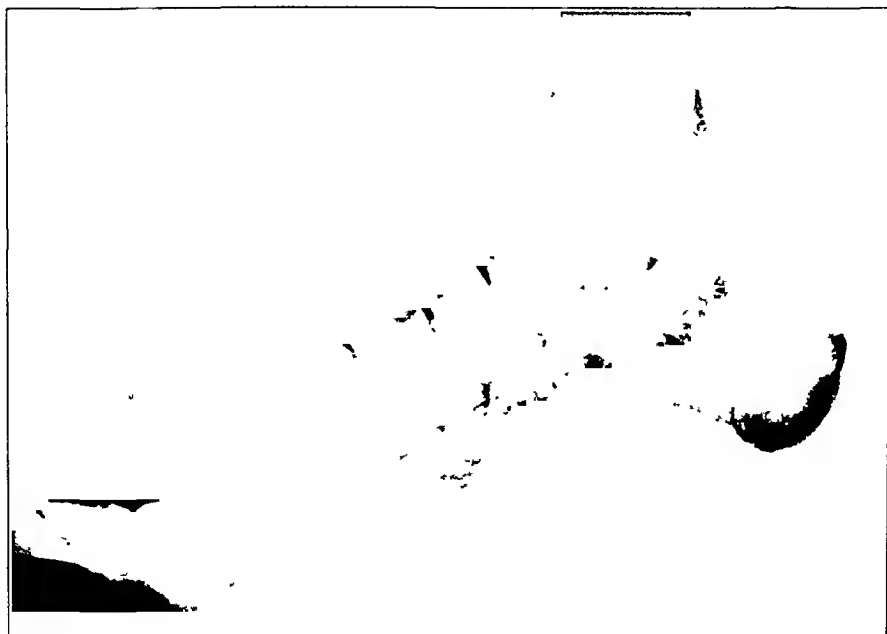


FIG. 5-B

Case 5. P. A. May 9, 1941. Two and one-half years after injury, the end result is excellent.

CASE 6. G. C. A man, nineteen years old, sustained bilateral comminuted fractures of the astragali, the left being compound, in an airplane crash, October 10, 1940 (Figs. 6-A and 6-B). Astragalectomy on the left, and astragaloscaphoid and subastragalar arthrodesis on the right were performed. In May 1941, the patient was getting about fairly well, wearing ankle braces which allowed limited motion. There was still



FIG. 6-A

Case 6. G. C. October 10, 1940. Compound, comminuted fracture-dislocation of the left astragalus.



FIG. 6-B

Case 6. G. C. December 2, 1940. Comminuted fracture of the right astragalus in same patient as shown in Figure 6-A, two months after injury. Note the sclerosis of the body.

slight drainage from the left ankle, and the right was painless with partial weight-bearing, although fusion was incomplete (Figs. 6-C and 6-D).

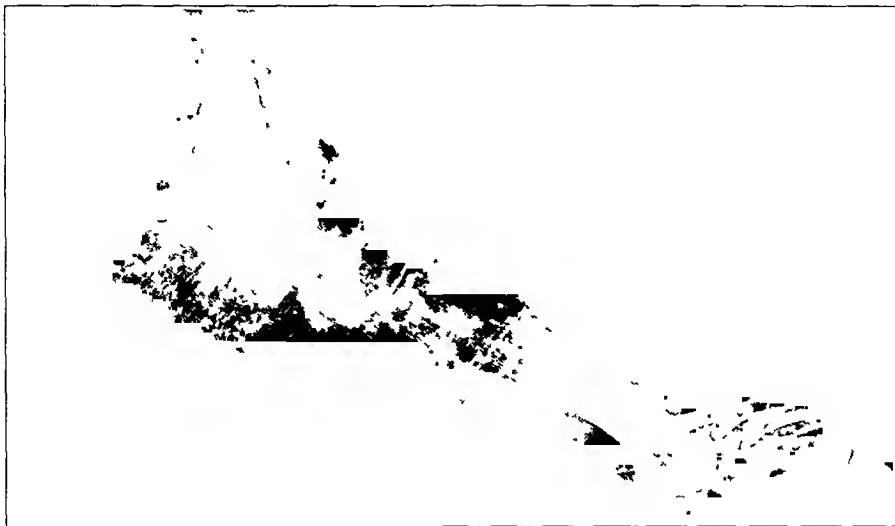


FIG. 6-C

Case 6. G. C. May 12, 1941. Seven months after astragalectomy on the left.



FIG. 6-D

Case 6. G. C. May 12, 1941. Five months after subastragalar arthrodesis on the right. Fusion is incomplete.

CASE 7. C. H. A man, twenty-five years old, sustained a complete external dislocation of the left astragalus with chip fracture of the head, in an airplane crash, May 25, 1930 (Fig. 7-A). Manipulative reduction was unsuccessful, and open reduction was performed May 31, 1930. Aseptic necrosis and drainage from the operative site developed several months later (Fig. 7-B). On December 22, 1930, astragalectomy was performed, followed by plaster fixation for twelve weeks (Fig. 7-C). The end result on April 30, 1941, was excellent functionally, although there was a tibiocalcaneal fusion and some thickening of the foot (Fig. 7-D). The patient walked without a limp and worked on his feet all day as a salesman, without pain or handicap.



FIG. 7-A

Case 7. C. H. May 25, 1930. Subastragalar and astragaloscaphoid dislocation on the left with chip fracture of the head of the astragalus.

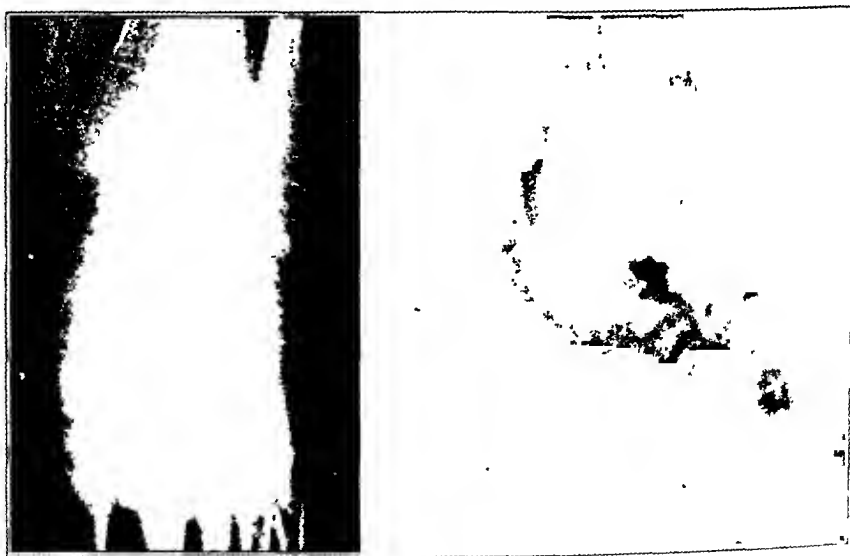


FIG. 7-B

Case 7. C. H. December 1930. Aseptic necrosis of the body of the astragalus seven months following open reduction.

Eleven years after operation, this case presents the best functional result in the series of ten necessary astragalectomies. Other observers report their most satisfactory functional results in those cases in which fusion of the tibia and the os calcis has taken place.

As a result of these studies, the authors recommend the following procedure in case astragalectomy seems essential. An immediate cal-

caneotibial arthrodesis is done, using, if available, a portion of the astragalus as a surface adaptor or wedge to decrease the amount of shortening in the extremity. The tibia is placed with its anterior margin in the vertical plane of the calcaneocuboid joint, and the foot is placed in the optimum position for the individual patient. In males, a minor degree of equinus (5 degrees) may be desirable; in females, the degree of the equinus used varies with their social status, but rarely is in excess of 15 degrees (Fig. 8). In the review of the literature referring to injuries to the astragalus, the authors have not found these principles previously described.

Complicating these injuries of the astragalus, a traumatic arthritis of the tibio-astragalar joint is relatively constant. It is reasonable to believe that compression injuries producing fracture-dislocations of the astragalus, would exert sufficient force upon the chondral surface of the tibia and the dome of the astragalus to produce impacted fractures or infracctions of these cartilage surfaces. Restitution of the cartilage to its normal status does not occur. It is the authors' feeling that the traumatic arthritis of the



FIG. 7-C

Case 7. C. H. Shows foot after astragalectomy.



FIG. 7-D

Case 7. C. H. April 30, 1941. Tibiocalcaneal fusion eleven years after injury. Function is excellent.

tibio-astragalar joint is produced as much by the initial injury as by the pathology subsequent to inadequate nutrition of the astragalus

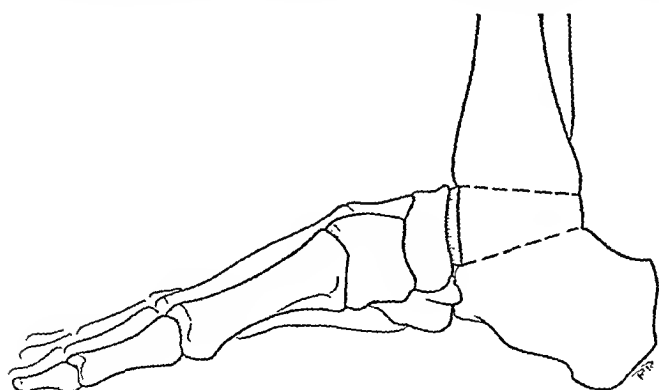


FIG. 8

Suggested calcaneotibial arthrodesis, using a portion of the astragalus as a wedge adaptor.

itself. The degree of pain and disability from this traumatic arthritis is the determining factor in deciding whether or not tibio-astragalar fusion should be done. In this series of cases, the necessity for this operation has not yet been encountered.

TABLE I
ANALYSIS OF THIRTY-TWO LESIONS IN THIRTY PATIENTS *

Injury	No. of Cases	Complications	Treatment	Result
Fracture of the neck	6	—	Manipulation 5 Open reduction 1	Excellent 5 Good 1
Chip fractures of the head	4	—	Manipulation 3 Excision fragment 1	Excellent 3 Good 1
Linear fractures of the body	3	—	Manipulation 2 Open reduction 1	Excellent 2 Fair 1
Comminuted fractures of the body	12	Compound (5)	Astragalectomy 10 Resection and arthrodesis 1 Débridement and reduction 1	Excellent 3 Good 3 Poor 1 Death 1 Too early 4
Dislocations	7	Minor fractures (5)	Manipulation 3 Open reduction 4	Excellent 5 Good 2

* There were 24 males and 6 females. The average age was 32.8 years.

SUMMARY

1. The blood supply to the astragalus is relatively poor, and transcervical fractures of the astragalus interrupt this blood supply.

2. Revascularization, after injury of the astragalus, is very tardy, and hence there is a high incidence of aseptic necrosis of varying degree, noticeable particularly in the body.

3. There is the necessity of early, anatomical reduction by manipulation or by open reduction, with or without internal fixation as indicated by the stability of the fragments. The articular dome of the body must be smooth and the calcaneo-astragaloid surfaces accurately apposed.

4. In those cases in which subastragalar contact is faulty, immediate subastragalar arthrodesis is indicated to obtain earlier function and to prevent a painful weight-bearing foot. Tibio-astragalar arthrodesis is indicated when there has been demonstrable damage to these cartilage surfaces.

5. In those rare compound dislocations with minor fractures, careful cleansing, detailed débridement, coupled with the local and general administration of sulfonamide derivatives, gives a greater chance for successful conservative surgery.

6. In those compound, badly comminuted fractures, the same technique gives a reasonable chance for immediate reconstruction.

7. In certain simple or compound, but severely comminuted, fractures of the astragalus, reduction and retention of the multiple fragments is impossible. Astragalectomy or calcaneotibial arthrodesis seems a necessity.

8. Calcaneotibial arthrodesis, according to the principles outlined, would appear to offer a more satisfactory result than astragalectomy.

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THE OPERATIVE TREATMENT OF RELAXED WEAK FEET

BY RALPH R. FITCH, M.D., AND BYRON B. KING, M.D., ROCHESTER, NEW YORK

The problem of the treatment of relaxed, pronated feet is at times difficult to solve. A procedure which is really based on a combination of the principles of the treatment described by Kidner and by Lowman has been devised by one of us (R. R. F.), and has proved useful in certain cases that have failed to respond to non-operative treatment. No claim for originality is made. The procedure is termed "the anterior and posterior tibial tendon transposition".

If the foot cannot be easily dorsiflexed passively to 90 degrees (with the tarsal joints locked by inverting the foot), the calcaneal tendon is lengthened the required amount. Then a three-inch curved incision, with convexity plantarward, permits an exposure of the medial portion of the scaphoid (navicular), and the insertions of the anterior tibial and posterior tibial tendons. If an accessory bone (os tibiale externum) overlying the scaphoid tubercle is present, it is freed from the posterior tibial tendon by sharp dissection, and is excised. If the tubercle of the scaphoid is unduly prominent, an adequate portion of its medial aspect is removed. The posterior tibial tendon is stripped from its attachment to the scaphoid, and its insertion is divided. The periosteum overlying the medial and inferior aspects of the scaphoid is incised and stripped up. With a small gouge, a groove is made in the posterior and inferior surfaces of the scaphoid. The sheath of the anterior tibial tendon is opened, and, with a small hook, the anterior tibial tendon is pulled medially over the tuberosity of the scaphoid, and is allowed to snap into the groove prepared for it. This changes its functional insertion to the highest point of the medial longitudinal arch. The periosteum is then resutured over the scaphoid, and the posterior tibial tendon is reattached at a point more distal and more plantarward than its original insertion. The wound is then closed, and a plaster cast from the toes to the mid-thigh is applied with the foot in 90 degrees' dorsiflexion. As the plaster sets, the forefoot is pronated and adducted, while the heel is molded into varus, thus making the best possible longitudinal arch. At the end of three weeks the cast is cut below the knee, and at the end of an additional five weeks the cast is removed. The patient then gradually begins weight-bearing, using a well-fitting arch support which is discarded five or six months later.

To date, only feet giving rise to symptoms of pain and fatigue have been subjected to this method of treatment. In the few patients operated upon, the symptoms have been relieved, and the foot posture has been improved. The authors feel that this procedure is best suited for feet with faulty foot posture and depressed longitudinal arches, rather than for feet with completely flattened longitudinal arches. It is advisable to confine its use to the relaxed type of weak feet; it should not be used for the spastic (rigid) type of weak feet.

Both feet were operated upon in one patient, and one foot was operated upon in three patients. The fifth patient has had one foot operated upon, and will have the other foot done in the future. The patients at the time of operation were ten, fifteen, seventeen, seventeen, and twenty-

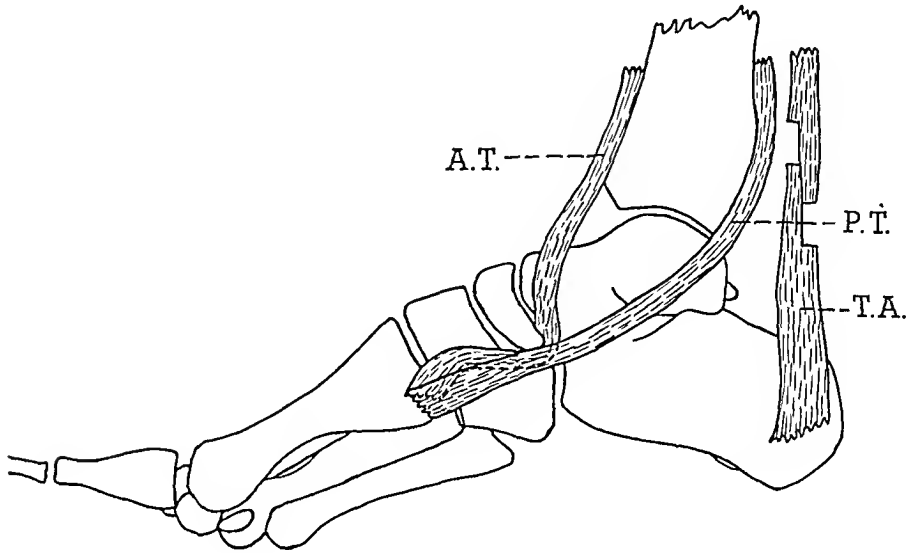


FIG. 1

Diagram of relationships after anterior and posterior tibial tendon transposition. The tendo achillis has been lengthened.

three years of age, respectively. There were two females and three males. They have been followed for two years and two months, one year and eight months, one year and seven months, one year and one month, and seven months, respectively, since operation.

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SURGICAL TREATMENT OF THE RESIDUAL DEFORMITY FROM SUPPURATIVE ARTHRITIS OF THE HIP OCCURRING IN YOUNG CHILDREN

BY PAUL H. HARMON, PH.D., M.D., SAYRE, PENNSYLVANIA

*From the Division of Orthopaedic Surgery, The Department of Surgery,
The University of Chicago*

Because of the large amount of cartilage in the component structures of the hip in young children, suppuration within the joint during the first two years of life runs a benign acute course as compared with the same disease during later childhood and adolescence. General recognition of the comparatively benign course of suppurative arthritis of the hip in young children has not occurred until recent years, when roentgenographic study of crippling disorders has become a commonplace procedure. The first recognition of the condition is frequently delayed until the child begins to walk, when the pathological dislocation of the hip is seen. As far as can be determined from the literature, Slowick was the first to set aside such a condition as an entity. The studies of Badgley, Yglesias, Perham, and Snyder and of Harmon and Adams upon 113 and 147 cases, respectively, of suppurative arthritis of the hip yielded data upon the natural course of this disease in untreated cases of all age groups and upon the course of the disease as modified by careful treatment. L'Episcopo pointed out the reconstructive possibilities in children, and proposed an operation to remedy the defect, which is a loss of the femoral head and neck. However, all of his cases were children several years older than those to be presented in this report. Only Hallock's report of the experience at the New York Orthopaedic Dispensary and Hospital with arthroplasty and reconstruction operations of the hip describes a reconstruction operation upon a young child similar to one of the cases to be described below. This last mentioned author operated upon a child one and a half years of age, suffering from the effects of suppurative arthritis and dislocation of the hip. His patient, however, presented a remnant of a femoral neck which was utilized in the reconstruction procedure. None of these previous authors appears to have recognized the unique potentialities of growth of the upper femur in the very young child, which can be utilized only if this type of pathological dislocation is recognized at an early age and treated promptly by operation.

CLINICAL COURSE OF ACUTE SUPPURATIVE ARTHRITIS IN THE VERY YOUNG CHILD

The general physician treats most of these cases, because the illness is usually not a severe one, and the condition is often mistaken for an abscess in the region. He is further misled by the rapidity with which the incised wound closes, as it usually heals in one or two weeks. With

subsiding inflammation, the child rapidly recovers from the infection. The damage that is done at this time does not become evident until the hip lurch produced by dislocation is seen for the first time when the child becomes ambulatory at the end of the first year of life. In order to understand fully the widespread destruction of the upper femur, when the original disturbance has been of a minor degree, it is necessary to recall that the upper femur, at this age, is largely, if not entirely, cartilage. The cartilage is readily destroyed in the presence of a pyogenic exudate¹¹, inasmuch as a tryptic ferment is present, which dissolves cartilage. This sequence of events is illustrated by both of the following case histories:

CASE 1. E. C. was first seen at the Clinic of the Home for Destitute Crippled Children, of the University of Chicago, at the age of twenty months. The mother stated that at the age of twenty-three days a swelling appeared upon the buttocks, accompanied by a high fever and temporary muscle spasm about the hip. The swelling was incised, and purulent drainage followed. Inasmuch as



FIG. 1-A

Case 1. E. C. Roentgenogram taken six months prior to operation, at the age of twenty months. Dislocation is evident from this view, but whether a remnant of neck remains, preformed in cartilage, cannot be positively ascertained.



FIG. 1-B

Case 1. E. C. Roentgenogram taken through plaster immediately after execution of the reconstruction operation. The bone grafts are well demonstrated.

roentgenograms were said to show no bone changes, a fact which was subsequently verified, the mother was told that this was merely a "boil upon the buttocks". The mother was concerned with the limp which the child had had since the age of one year, and she requested an explanation of it.

Roentgenograms (Fig. 1-A) gave the explanation. The shadows of the head and neck of the right femur were missing, and the greater trochanter was displaced upward.

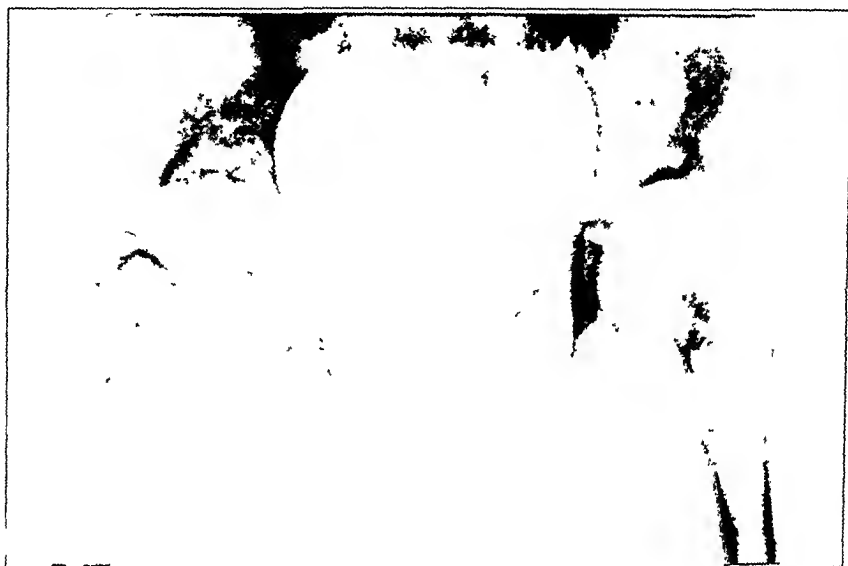


FIG. 1-C

Case 1. E. C. Five months after operation, and two months after removal from plaster and resumption of weight-bearing.

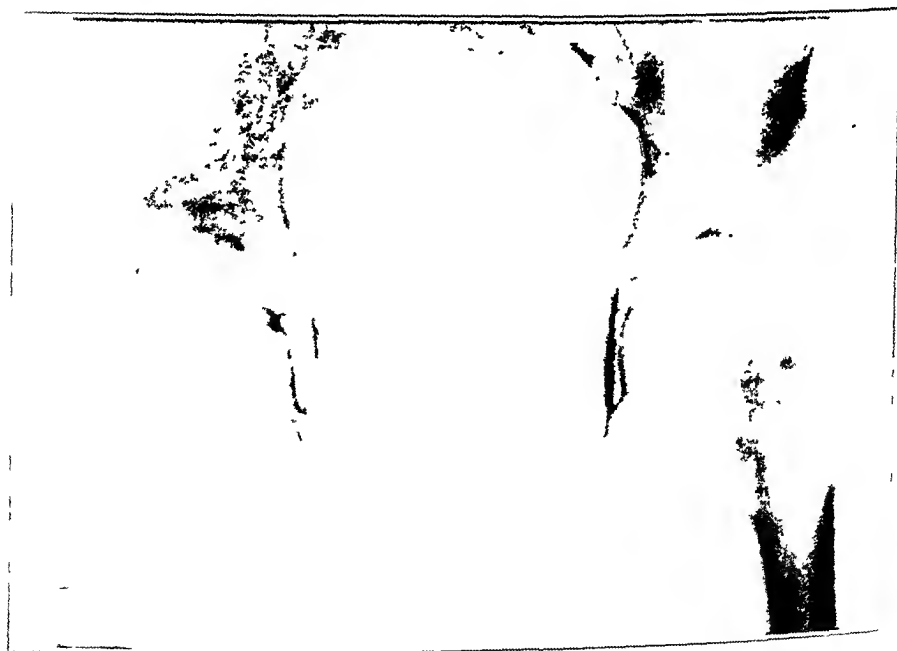


FIG. 1-D

Case 1. E. C. Three years and eight months after operation. Note the maintenance of joint space in the reconstructed hip. The greater trochanter, however, has continued to grow in a superior direction.

Examination showed unrestricted passive motion at the right hip. The right greater trochanter ascended to a slight degree, when attempts were made to telescope the right leg upon the trunk. The right leg measured (anterior superior iliac spine to internal malleolus) thirty-seven and five-tenths centimeters, while the corresponding measurement upon the left was thirty-nine and five-tenths centimeters.

The patient was admitted to the Hospital, and on April 2, 1937, an attempt was made to reduce a hypothetical cartilaginous femoral head into the right acetabulum. When this failed, an open operation was performed. The hip was approached by the anterior route, the sartorius being retracted medially. After the joint capsule, which was adherent to the lateral surface of the ilium, had been opened, the true situation was seen. There was no femoral head or neck. The medial surface of the upper shaft, formerly the junction of the neck and shaft, was covered by fibrocartilage. The acetabulum was filled with soft proliferated synovial tissue, but, following the removal of all soft tissues, its depth was found unreduced. The reconstruction operation to be described (Figs. 1-B and 3-B) was then carried out. The incision was closed in layers in the usual manner, after the leg had been abducted and the position of the medial fragment in the acetabulum had been verified. The cast was allowed to remain in place for three months, after which the patient was permitted to become ambulatory with crutches. Six months after the operation (Fig. 1-C) he was walking with a slight limp, but without support. He continued to improve, so that nine months after operation no limp was present. For the following two years the patient walked without any limp. During this time, roentgenograms showed that the newly formed femoral neck remained beneath the acetabular rim, and the hip remained stable.



FIG. 1-E

CASE 1. E. C. Three years and eight months after operation. At this time the patient's gait was excellent except for three and five-tenths centimeters of shortening present in the right leg.

He was last examined on December 17, 1940, (Figs. 1-D and 1-E) at which time his gait was excellent, except for shortening of the leg, which had developed. The measurements of leg length were (anterior superior spine to internal malleolus) fifty-two and five-tenths centimeters on the left and forty-nine centimeters on the right. Ninety degrees of free active flexion from the neutral position was present. There were 10 degrees each of active adduction and abduction, but rotation, while present, was less than 10 degrees. The right greater trochanter was palpable slightly below the level of the anterior superior iliac spine.

CASE 2. D. P. C., male, was seventeen months of age when first seen by the author. The infant was greatly emaciated, the parents stating that his illness of the previous eight weeks had caused loss of almost half his body weight. One week after the onset of the original disorder, which according to the family physician was accompanied by a painful flexion deformity of the left hip and knee, abscesses were incised anterior to the left knee and posterolateral to the left hip. After copious discharge of purulent material, both abscesses healed within ten days. No cultures for bacteria were made.

Upon examination at the age of seventeen months, six weeks after the healing of the wounds, the child would not attempt to stand or walk, and could maintain a sitting position only with aid. The skin was lax over the underlying tissues, and retardation of

development was evident from extensive generalized muscle atrophy, the potbelly, and the wide separation of both the anterior and posterior fontanelles. There was a flexion deformity of 30 degrees at the left knee and 15 degrees at the left hip. Crepitation could be elicited at the left knee. The other joints were normal. Measurements from both the umbilicus and the anterior superior iliac spine showed the left leg to be three-fourths of an inch shorter than the right. Attempts to produce further apparent shortening by telescoping the left leg upon the trunk failed, this hip being as stable as the normal hip.

Roentgenographic examination (Fig. 2-A) showed upward displacement and irregularity of the left superior acetabular bone cortex (wandering acetabulum). The head of the left femur appeared to be still entirely cartilaginous, but from the relation of

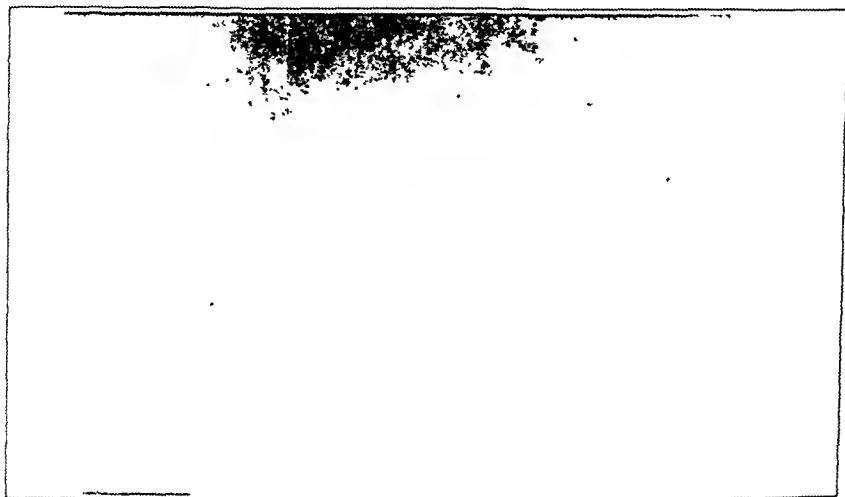


FIG. 2-A

Case 2. D. P. C. At the age of seventeen months.

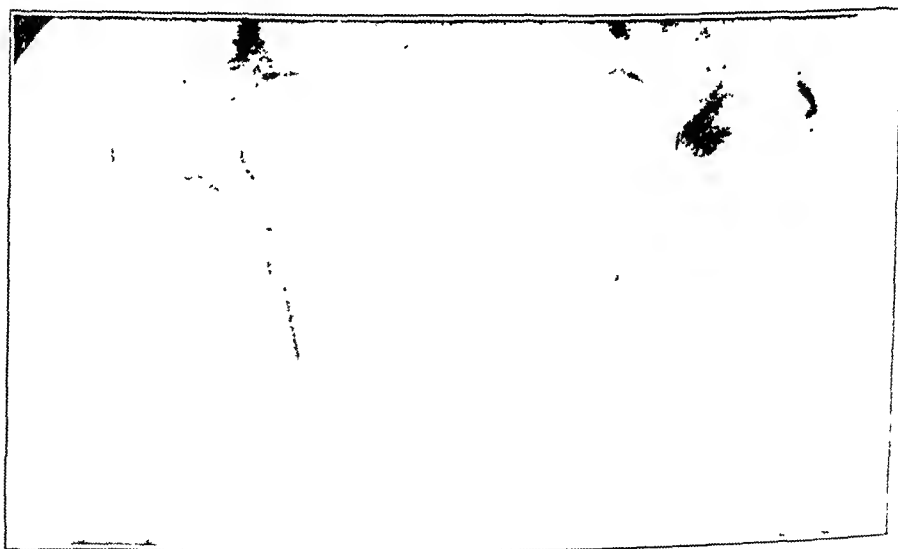


FIG. 2-B

Case 2. D. P. C. At the age of four years and two months. An osseous center has appeared in the upper left femur, which has remained stable in the acetabulum, although the acetabulum has "wandered" during the stage of acute suppuration.

the neck to the acetabulum it was certain that the cartilaginous femoral head was in the acetabulum. A slight coxa vara deformity was present on the left. The femoral deformity and the upward displacement of the acetabulum were sufficient to account for the measured clinical shortening.

In view of the stability of the hip, present because of sufficient preservation of cartilage of the femoral head center, the only indication for treatment was to eliminate the flexion deformities of the left hip and knee. This required four months' recumbency in the Hospital with the left leg in almost constant traction. During this time, the patient regained the general body weight that had been lost, and his general appearance improved because of better nutrition.

He was last seen at the age of four years and two months. At that time, when wearing shoes with a half-inch elevation on the left heel, he walked without a limp. Measurements of leg length showed that no further discrepancy of length (three-quarters of an inch) had occurred in the three years since the first visit. Passive motion at the left hip was free, painless, and normal except in extension, abduction, and adduction, which were limited to about two-thirds of normal. There was no restriction in motion at the left knee and the flexion contracture had not recurred.

Röntgenograms (Fig. 2-B) on this latter date were not dissimilar to those taken three years previously. An osseous center to the upper left femoral epiphysis was now definitely present. No active treatment was indicated except the slight raise on the heel of the left shoe.

OPERATIVE TECHNIQUE

Figures 3-A and 3-B demonstrate the operative attack upon the bone, as carried out in performing the reconstruction of the upper femur in this group of very young children. The anterior and upper fourth of the femoral shaft is bared subperiosteally. The leg is rotated so that the toes are in the anterior vertical plane. This positioning is of importance, since subsequent rotation of the limb depends upon it. The muscles are not stripped from the greater trochanter. From four to six drill holes are placed through both the anterior and posterior cortex, as shown in Figure 3-A. Placement of these holes guides subsequent splitting of the shaft, which is carried out from above downward with a short, thin-bladed osteotome. The medial fragment, which is covered by fibrocartilage, is split medially and brought under the acetabular roof. Any soft tissues projecting into the acetabulum are removed by curettement, care being taken not to injure the cartilage. Bone grafts which have been removed from the opposite tibia are then placed as shown in Figure 3-B,—one being used as a strut across the mouth of the bone incision and the other being wedged into the inferior angle, so as to maintain the fixed separation of the shaft fragments. The muscles are then allowed to fall into place, and those which were partially detached from the anterior ilium are reattached by periosteal stitches of fine plain catgut. The deep fascia and subcutaneous layers are closed by fine plain catgut, and the skin edges are united with a non-absorbable suture.

The technique as described above is applicable only when the acetabulum is undamaged or altered to only a minor degree by preexisting disease, which is usually the case in the group of very young children dealt with in this report. If the acetabular roof is too shallow or is non-existent,

a new acetabulum is prepared by gouge and small ball reamer at the level of the normal contralateral acetabulum. Correct positioning of the new acetabulum can be checked by identification of the remains of the triradiate cartilage. A shallow foreign-body cup is then placed in the newly formed acetabulum. Vitallium has been utilized in hip-joint arthroplasty by Smith-Petersen, while the author has used cups of methacrylate for this purpose. In girls the possibility of pelvic deformity due to closure or distortion of the zone of enchondral ossification should be discussed with the parents when this manoeuvre becomes necessary.

DISCUSSION

These instances of residual suppurative arthritis in the very young child represent a special group from the point of view of the necessity of early diagnosis and continued follow-up, in order to determine the necessity for reconstructive procedures, and to obtain the benefits from reconstruction at an early age.

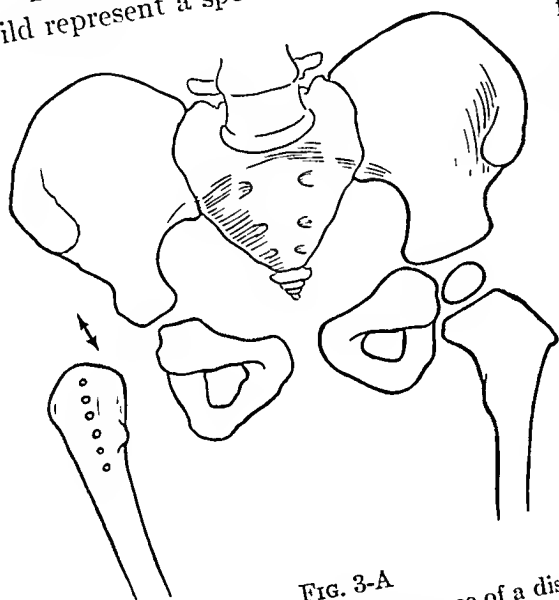


FIG. 3-A

Sketch illustrates the appearance of a dislocating hip prior to the operative reconstruction procedure. The location of anteroposterior drill holes in the femoral shaft, outlining the line of the proposed bone incision, is shown.

of the hip, during the past five years. However, this, it is felt, is due to relatively scant attention paid to crippling conditions in very young children in the past by the general physician. In a review of 147 pyogenic hips in 132 patients reported by Harmon and Adams, there were twenty-two hips (14.9 per cent.) in which the pyogenic process began before the age of three years; the majority began during the first year of life.

From the point of view of roentgenographic diagnosis, cases of the type illustrated in Figure 4 (traumatic periostitis in the newborn) might be confused with the dislocating hip of the very young child. Quite rarely the question of osteogenic sarcoma might be raised in the differential diagnosis. This latter condition is indeed a rarity, as the statistics from the Registry of Bone Sarcoma of the American College of Surgeons⁴

show only a single doubtful case in the lower femur of a boy of three, and Geschickter and Copeland report a single case in the upper femur as a congenital osteogenic sarcoma discovered in an infant of forty-six days. Both cases resulted fatally, but the value of either is lessened because a necropsy was not obtained.

Roentgenograms shed much light upon the nature of the process. From them, one can usually establish the presence or absence of dislocation, particularly if a second view is taken while an attempt is being made to telescope the femur into the trunk on the involved side. Boxing the extra acetabular space by lines described by Perkins makes the determination of dislocation more certain when the epiphyseal center is absent or delayed in appearance, or when the cartilage in which it subsequently is to appear has been damaged by the disease. The entire subject of the roentgenography of the infantile hip joint has recently been reviewed by Burman and Clark.

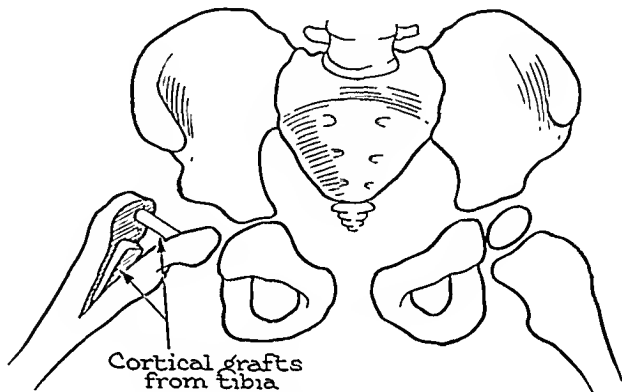


FIG. 3-B

Sketch shows the completed operation upon the bone, and the rôle of the cortical bone grafts from the opposite tibia in maintaining the position of the fragments.

Reference to the roentgenograms of

Case 1 shows that a joint space has been maintained in the reconstructed hip for a period of four years. The cartilage space appears in recent roentgenograms (Fig. 1-D) to be of the same width as that of the normal hip. The increase in width and depth of the acetabulum on the side on which the operation was performed appears to be keeping pace with that in the normal hip, although there is more obliquity in the former than in the latter. There is likewise an increase in the transverse diameter from the trochanter to the medial osseous surface of the reconstructed femoral neck, but the trochanter on this side is increasing its superior height at the expense of the neck, and a coxa vara is developing. Experience with cases of active suppuration in children has shown that preservation of stability is maintained where remnants of the partially ossified neck remain after destruction by the suppurative process or epiphysiolysis. By analogy, it is probable that the neck remnant created by reconstruction will be adequate to stabilize the hip for years to come. In the future, the necessity for some procedure to bring about equalization of leg length should be contemplated in this and similar cases.

While the roentgenograms and drawings show the procedure to be similar to that applied by Albee to ununited fractures of the femoral neck,

no "increased leverage" is anticipated, as in the very young child the end result is that of restoring a semblance of the normal contour to the upper femur, and of stabilizing this structure in the acetabulum.

SUMMARY AND CONCLUSIONS

Suppurative arthritis of the hip in the very young child usually runs a benign acute course, but results in destruction of the entire cartilaginous portion of the upper femur. When the child begins to walk, the pathological dislocation so produced is evident.

The presence of the pathological dislocation cannot always be decided from a study of roentgenograms. Physical examination and comparative roentgenographic study of the pelvis, when reverse traction is applied to the abnormal leg, may demonstrate a hip stabilized by sufficient cartilage.

When the presence of a pathological dislocation is demonstrated, good results may be obtained by the type of reconstruction operation described in this report. The optimum time for this operation is during the second and third years of life. Roentgenograms taken prior to operation will demonstrate any internal markings in the bone which might contra-indicate the reconstructive operation.

While only two reconstruction operations

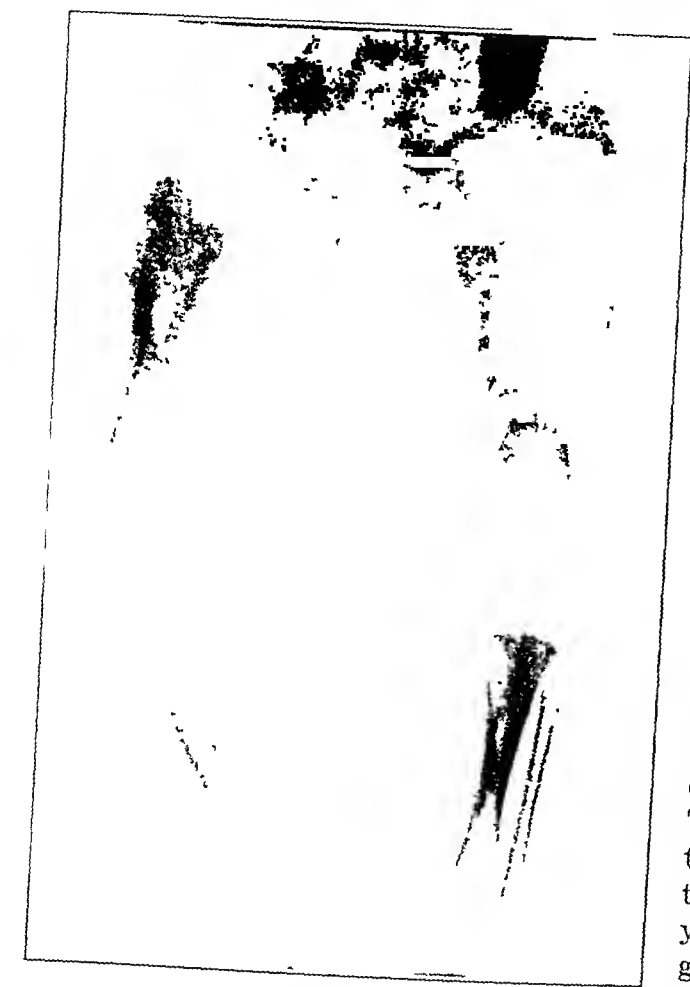


FIG. 4

Roentgenogram of the pelvis and femora of an infant, two months of age, showing in the right upper femur the changes that have been described as "traumatic ossifying periostitis of the new born". This child was followed by roentgenograms for four years, during which time the changes shown persisted almost unchanged. Full motion was preserved in the right hip.

upon children so young have been reported (Hallock's case and the one presented here), the amount of articular bone produced, and the subsequent stability of the hip favor the early recognition of these rare cases, and their immediate treatment by reconstruction. The patients should

then be followed closely and appropriate measures should be taken to equalize leg length as indicated.

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NEUROGENIC SARCOMA *

BY I. H. MASERITZ, M.D., BALTIMORE, MARYLAND

The term neurogenic sarcoma is applied to a group of tumors which have their origin in the connective tissue supporting nerves. These tumors may occur as primary malignant growths, or may arise in a previously existing benign neurofibroma. They are varieties of fibrosarcoma, but possess certain characteristics common to growths of the nerve sheath.

TABLE I

LOCATION OF NERVE-SHEATH SARCOMA IN 192 OF THE CASES PRESENTED

Scalp	3
Face	6
Neck	8
Shoulder	8
Deltoid region	3
Axilla (soft parts)	2
Arm	8
Elbow	2
Forearm	10
Hand	7
Fingers	5
Body wall	8
Chest	4
Abdomen	11
Buttock	4
Hip	7
Thigh	38
Knee	12
Leg	21
Ankle	10
Foot	9
Toes	3
Pubis	2
Mesentery	1
	<hr/>
	192

The present series includes 216 cases of solitary primary neurogenic sarcoma of soft parts. Although multiple malignant nerve-tissue tumors have been reported by Herxheimer and Roth, Krause, Cestan, and others, none were observed in the material available for this study.

Stewart and Copeland (1931) reported 130 cases of primary neurogenic sarcoma, sixty-six cases having been collected from the literature and the others taken from the Memorial Hospital, New York City. The nerves in which these tumors originated were specified in the cases

* The data used in this article were collected from the records of the Surgical Pathological Laboratory of the Johns Hopkins Hospital, Baltimore, Maryland.

TABLE II
DURATION OF SYMPTOMS IN SIXTY-EIGHT CASES

Period of Time	No. of Cases
0 to 6 months	23
6 months to 1 year	11
1.5 years	6
2 years	4
3 years	5
4 years	4
5 years	1
6 years	2
7 years	1
8 years	1
9 years	1
10-20 years	7
20-40 years	1
40 years	1
Total	68

collected from the literature, while no origins were given for their own cases. (Table I shows the regions involved by the tumors in the present series.) Stewart and Copeland, Ewing, and others believe that the majority of the so-called fibrosarcomata arising in the extremities and

TABLE III
RECURRENCES

Period of Time	No. of Cases	
	Single Recurrences	Multiple Recurrences*
6 months	15	1
1 year	4	5
1.5 years	4	3
2 years	3	2
3 years	2	2
4 years	5	1
5 years	1	0
6 years	2	0
7 years	1	0
8 years	1	0
10-20 years	0	3
Total	38	17

* Seventeen patients had multiple recurrences, four of whom had more than two recurrences

body wall are of nerve-sheath origin. The author is of the same opinion, since many sarcomata of the nerve sheath, which arise from unimportant branches of a nerve, and which have no demonstrable anatomical



FIG. 1

P. N. 3981. Clinical photograph in case of neurogenic sarcoma arising from the sciatic nerve.

relationship to nerves at the time of operation, present the same gross and microscopic features as those growths which are known to arise from the larger nerves, and as in cases of von Recklinghausen's disease. The location, clinical behavior, and especially the gross and microscopic findings are sufficient evidence of their nerve-sheath origin. The destructive character of these growths makes it impossible in some cases to dissect out the nerves from which they arise.

In the present series of primary sarcomata there were 106 males, 102 females, and eight instances in which the sex was not reported. Thirteen instances occurred in members of the colored race. Age was recorded in only 144

cases. The highest peak was reached in the third decade,—thirty-nine cases. There were ten cases in the first decade; twenty-eight in the second decade; three in the fourth; thirty-three in the fifth; fifteen in the sixth; and sixteen in the seventh. The cases collected by Stewart and Copeland included seventy males and fifty-five females. The majority of cases occurred between twenty and fifty years.

The distribution of the lesions in the author's series varied. The largest group, 149 out of 192 cases in which the sites of the lesions were specified, involved the extremities (Table I). In most instances, the symptoms consisted of a painless swelling. Symptoms resulting from nerve pressure or destruction occurred occasionally. The duration of symptoms in thirty-four, or 50 per cent. of the cases in which such data were recorded, was one year or less (Table II).

GROSS PATHOLOGY

Sarcomata of the nerve-sheath are gray, firm growths, often leathery in consistency, which tend to infiltrate the surrounding structures (Fig. 2). The mass of the tumor is usually fairly well circumscribed.

The gross appearance resembles fibrosarcoma of fascial or periosteal origin. Cystic degeneration is not uncommon.

MICROSCOPIC PATHOLOGY AND HISTOGENESIS

The tissue observed in the earliest phase of tumor formation is mesenchymal in appearance. The cells are round or oval, and possess little or no visible cytoplasm (Fig. 3).

They are irregular in size and are frequently multinucleated. These multinucleated cells are the forerunners of the large, malignant, giant cells, described as a criterion for the diagnosis of this type of sarcoma by Quick and Cutler, Jackson, and Herxheimer and Roth. Both the multinucleated and mononucleated cells are embedded in a pink-staining, homogeneous, intercellular substance. Many of the embryonic mesenchymal cells, with further growth, become spindle-shaped. Fibrospindle and fibroblastic cells, such as are found in fibrosarcomata elsewhere in the soft parts, are seen in Figure 4. The intercellular substance increases, and collagen fibrils replace the pink-staining ground substance in the more differentiated portions of the tumor. The fibrils become more conspicuous, and resemble those in the benign forms of nerve-sheath tumors. A

tendency to palisading is often observed, and in some instances is very similar to that in perineural fibroblastomata. Whirls of fibrils with central areas of colloid-like material and pseudoelumping are some of the changes observed (Fig. 5). In some instances, mesenchyme, fibromyoma, and fibroblastic sarcoma are intermingled, and suggest the transition of mesenchyme to fibromyoma and to fibrosarcoma. Fibromyxomatous tissue is also observed in neurofibromata, undergoing malignant transformation, but without evidence of mesenchyme proliferation.

In summary, sarcoma of the nerve sheath resembles microscopically fibrosarcoma of the soft parts, differing in minor aspects from fibrosarcoma in the same way that benign neuromyoma differs from simple fibroma.

PROGNOSIS AND TREATMENT

Treatment in the vast majority of cases consisted of excision. This operation was performed for the primary growth and for most of the



FIG. 2

P. N. 15065. Gross specimen of neurogenic sarcoma of the soft parts.



FIG. 3

P. N. 51382. Photomicrograph (high magnification) of a neurogenic sarcoma showing the earliest observable phase of tumor formation.

recurrences. Amputation was occasionally practised. Irradiation in this series proved of little value. Amputation is the treatment of choice when the sarcoma occurs along the deep nerve tracts of the extremities. Of thirty-eight instances of single recurrences, nineteen, or 50 per cent., recurred within one year following operation. The maximum time interval for recurrence after initial treatment was eight years. In thirteen of the seventeen instances of multiple recurrences, there were two recurrences only (Table III).

The end results were traced in 115 of the 216 cases. Thirty-eight patients were living. Eighteen of these patients had lived less than five years; ten, from five to ten years; eight, from ten to twenty years; and two over twenty years. There were seventy-seven deaths. The duration of life was determined in forty-three cases; thirty-nine of these patients died within the first three years following operation or treatment.

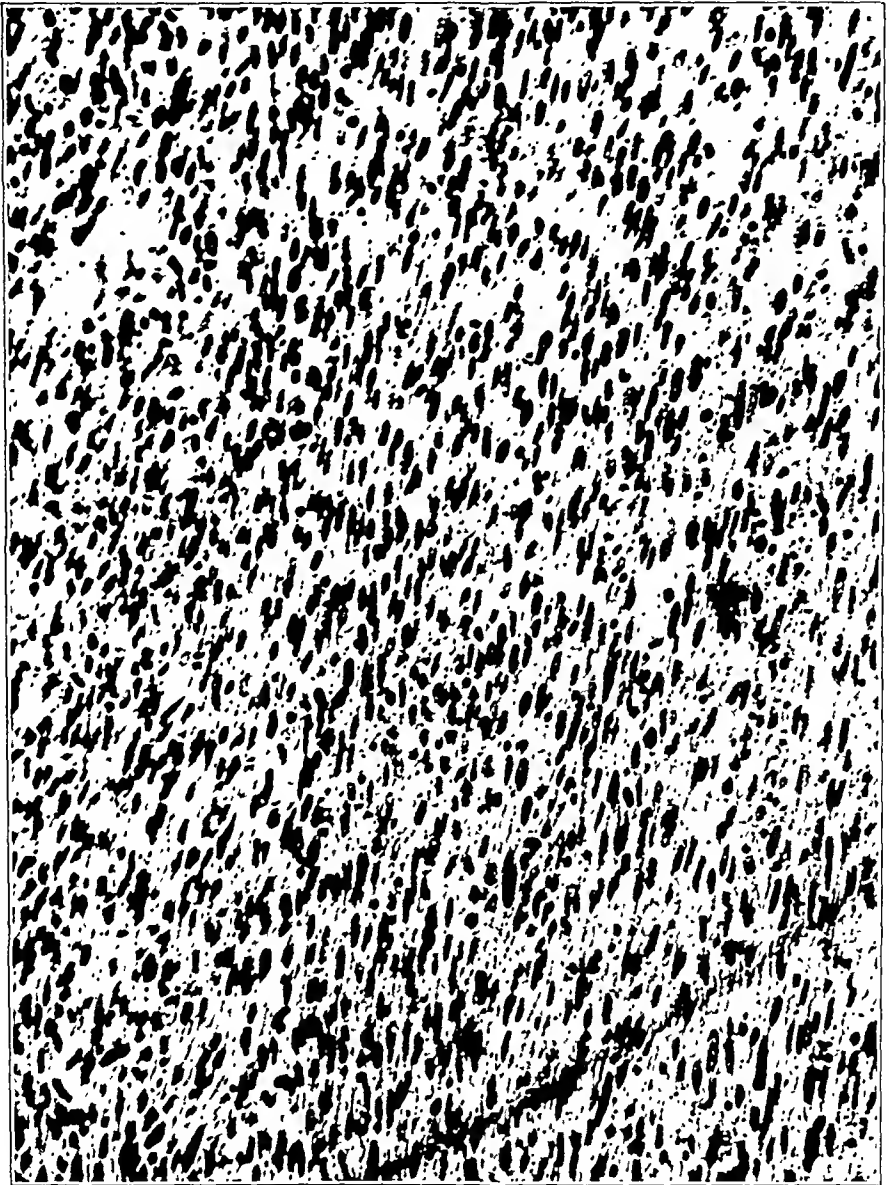


FIG. 4

P. N. 31775. Photomicrograph (medium magnification) of a neurogenic sarcoma showing fibrospindle and fibroblastic cells, and fine strands of collagen fibers in a more advanced stage of tumor formation. Compare with Fig. 3.

MALIGNANT TRANSFORMATION IN VON RECKLINGHAUSEN'S DISEASE

In the Surgical Pathological Laboratory there are thirty-six patients listed as having von Recklinghausen's disease. Malignant transformations had occurred in four instances, or in 11.1 per cent. Ten cases of sarcomatous transformations in von Recklinghausen's disease were listed under neurogenic sarcoma, but could not be included in this computation



FIG. 5

P. N. 48100. Photomicrograph of neurogenic sarcoma in which the arrangement of tissue is in benign palisading neurinoma. The cellularity of the clump indicated by arrows from *a*, and the dusky nuclei are

since the material was derived from clinics other than the Johns Hopkins Clinic. Thomson (1900) had collected eighteen instances of neurogenic sarcoma in a series of seventy-seven cases of von Recklinghausen's disease, an incidence of 23.4 per cent. Hosoi (1931) was able to collect sixty-five cases of sarcomatous transformation in von Recklinghausen's disease. He found that these changes occurred in 13 per cent. of the cases as compared with 12 per cent. reported by Garré. In Hosoi's series there were thirty-nine males and twenty-four females. The youngest was fifteen; the oldest, seventy years; while 72 per cent. of the cases occurred in the third, fourth, and fifth decades.

In a total of fourteen cases from the Johns Hopkins Laboratory, in which such data were available, there were six males, five females, and three instances in which the sex was not reported. The ages at which transformation occurred varied from twenty to forty-five years, the average being thirty-four years.

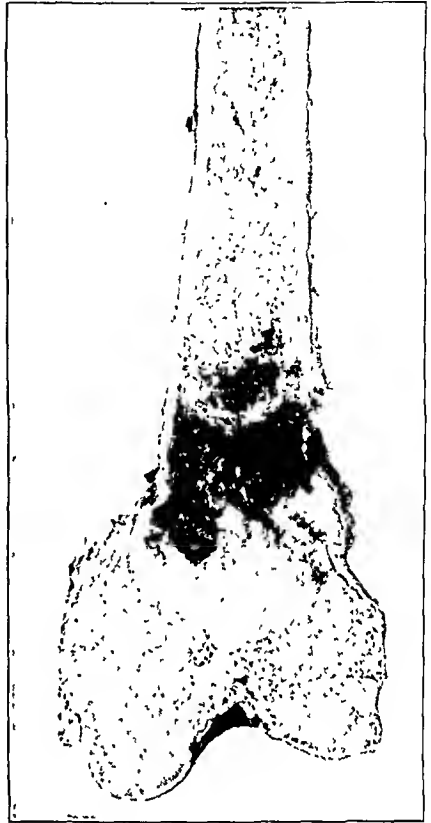


FIG. 6

P. N. 26593. Gross specimen in a case of primary neurogenic sarcoma of the femur.

PRIMARY NERVE TUMORS OF BONE

Brooks and Lehman (1924) reported several cases of von Recklinghausen's disease in which neurofibromata arose from the periosteum or in bone. Peers (1934) described an intramedullary tumor of the ulna which histologically proved to be a malignant schwannoma (neurogenic sarcoma).

In the present series there are six instances of primary neurogenic sarcoma of the soft parts, which secondarily invaded bone by direct extension. The tibia, ulna, femur, and a rib were each involved once, and the tarsal bones were involved twice.

In two instances neurogenic sarcoma arose from the periosteum of bone, and invaded both the osseous and soft-part structures. Four cases consisted of primary central neurogenic sarcoma of bone. The source of origin is somewhat doubtful, but is thought to be the nerve fibers accompanying the blood vessels. These cases with bone involvement were all in the white race. There were two males and two females. The ages varied from nine to sixty-seven years. The femur was involved in

three instances and the coccyx in one. The roentgenographic changes were not unlike those of primary or secondary osteoclastic bone tumors (Fig. 6), the diagnosis being made only after biopsy. Treatment consisted of irradiation in two instances and amputation in four. In one of the cases treated by irradiation the patient died; in the other, the result could not be traced. Two of the patients treated by amputation were cured; one of the others died two years after amputation.

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THE PATHOLOGICAL CHANGES IN RECURRENT DISLOCATION OF THE SHOULDER

A REPORT OF BANKART'S OPERATIVE PROCEDURE *

BY FREDERIC C. BOST, M.D., AND VERNE T. INMAN, M.D.,

SAN FRANCISCO, CALIFORNIA

*From the Department of Surgery, Division of Orthopaedic Surgery, University of California
Medical School, San Francisco*

The authors' interest in the pathological changes occurring in recurrent dislocation of the shoulder joint was stimulated by the paper of Bankart² who reported twenty-seven consecutive cases in which he had observed a detachment of the labrum glenoidale from the anterior aspect of the glenoid rim. He stated that this injury was the "essential" and the sole lesion in recurrent dislocation of the shoulder; in his opinion, the fibrocartilaginous structure of the detached labrum glenoidale precluded its reattachment to the glenoid rim, and thereby created a permanent weakness of the anterior part of the shoulder joint, predisposing the joint to recurrent dislocations.

Bankart believed that it is the specific character of the original dislocating trauma that determines the future tendency to recurrence. Whereas the ordinary anterior dislocation is produced by an abduction external-rotation leverage force, sheering off of the labrum glenoidale is produced by a forwardly directed force applied to the shoulder from behind.

It was Bankart's contention that the "essential lesion" has been overlooked, because the demonstration of the tear of the labrum glenoidale requires a special exposure of the shoulder joint. The operation which he performed is as follows (Fig. 1):

1. The shoulder joint is approached through a longitudinal incision which separates the deltoid and pectoralis major. This is facilitated by partial separation of the attachment of the pectoralis major from the humerus.

2. The tip of the coracoid process is detached and turned downward and medially with the attachments of the short head of the biceps tendon and coracobrachialis and pectoralis minor.

3. The humerus is rotated outward and the subscapularis tendon is divided near its insertion into the lesser tuberosity. The muscle is then drawn medially to expose completely the anterior shoulder joint.

4. The entire anterior aspect of the joint may be observed. If there is a tear through the capsule, the detached labrum glenoidale appears to be retracted with the capsule, either over the head of the humerus or over the

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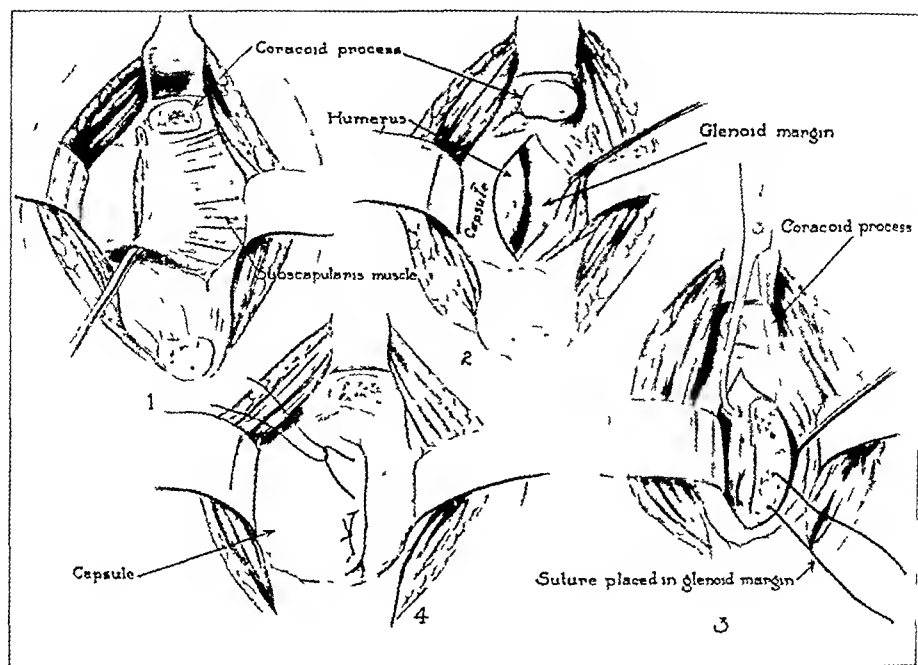


FIG. 1

Diagrammatic representation of the Bankart operation

neck of the scapula. If the capsule is intact, it is incised parallel to the glenoid rim, exposing the detached labrum. After this procedure, the margin of the glenoid rim may be readily inspected. In Bankart's words, "In every case the anterior margin of the glenoid cavity will be found to be smooth, rounded, and free from any attachments, and a blunt instrument can be passed freely inwards over the bare bone on the front of the neck of the scapula".

5. The glenoid rim is raised with a chisel and the free edge of the capsule, with or without the labrum glenoidale, is sutured to the bony margin.

6. The divided structures are replaced, and the arm is bandaged to the side for four weeks.

In Bankart's experience, the repair of this "typical", "uncomplicated", "essential" lesion has invariably prevented recurrence of the dislocation.

These observations seem to refute much that had been previously recorded concerning the etiology of recurrent dislocations. Although much confusion surrounds the subject, it was difficult to reject summarily the many careful observations and studies of other workers. For this reason the present investigation was undertaken.

Since September 1938, the authors have used Bankart's procedure in ten consecutive cases of recurrent dislocation of the shoulder. In every instance the tear of the labrum glenoidale as described by Bankart was found, and unquestionably this lesion is of primary significance in recurrent dislocation. In each of these ten shoulders, however, there were

additional pathological findings,—namely, erosion of the ventral glenoid rim and roentgenographic evidence of a defect in the posterolateral portion of the head of the humerus.

ANATOMY OF THE SHOULDER JOINT

An appreciation of the pathological changes of recurrent dislocation must be based upon an accurate conception of the anatomy of the shoulder joint. The unsatisfactory descriptions in standard textbooks of anatomy led to the study of a number of especially prepared dissections (Figs. 2 and 3). The hemispherical head of the humerus articulates with the shallow concavity of the glenoid fossa, but scarcely one-quarter of its articular surface is in contact with the fossa at any time. The fossa is pear-shaped in outline,—being narrower above than below. Its rim presents a shallow notch in its anterosuperior part, through which the upper tendinous fibers of the subscapularis play, and this notch indicates on the bone specimen the position of the subscapular bursa. The antero-inferior margin is slightly elevated above the level of the remaining portions of the rim, giving added support to the humeral head at this point. The glenoid cavity is very shallow, but, in the fresh state, it is deepened and enlarged by the labrum glenoidale and by the fact that its cartilaginous lining is thinnest centrally.

The labrum glenoidale is a ring of dense fibrocartilaginous tissue attached to the margin of the glenoid. This structure is triangular in section, one side being applied to the surface of the glenoid rim, overlapping the articular cartilage to which it is loosely fastened. Its firmest attachment skirts the outer edge of the glenoid rim, where it is bound down by dense fibrous tissue. The other two surfaces of the labrum are free. One surface is in contact with the head of the humerus and the other with the capsule of the joint. The capsule extends, however, for several millimeters beyond the labrum before being reflected onto the glenoid rim, thus forming a narrow furrow which lies between the capsule and the labrum.

Antero-inferiorly there is a definite and constant thickening of the subsynovial connective tissue of the capsule, extending from the edge of the labrum to the neck of the humerus, which at this level obliterates the furrow. This structure is the inferior glenohumeral ligament. A similar thickening in the capsule is found anterosuperiorly, parallel to the biceps tendon which extends from the glenoid rim toward the lesser tuberosity. This structure is the superior glenohumeral ligament. The opening of the subscapular bursa lies directly below this ligament and forms the upper margin of the bursal aperture. The synovial fibrous capsule of the shoulder joint is thin anteriorly, and can be separated from the subscapularis tendon on the scapular side; but, as it is followed laterally, it blends intimately with the tendon.

The manner in which the subscapular bursa opens into the shoulder joint is subject to minor variations. The upper margin of its aperture is

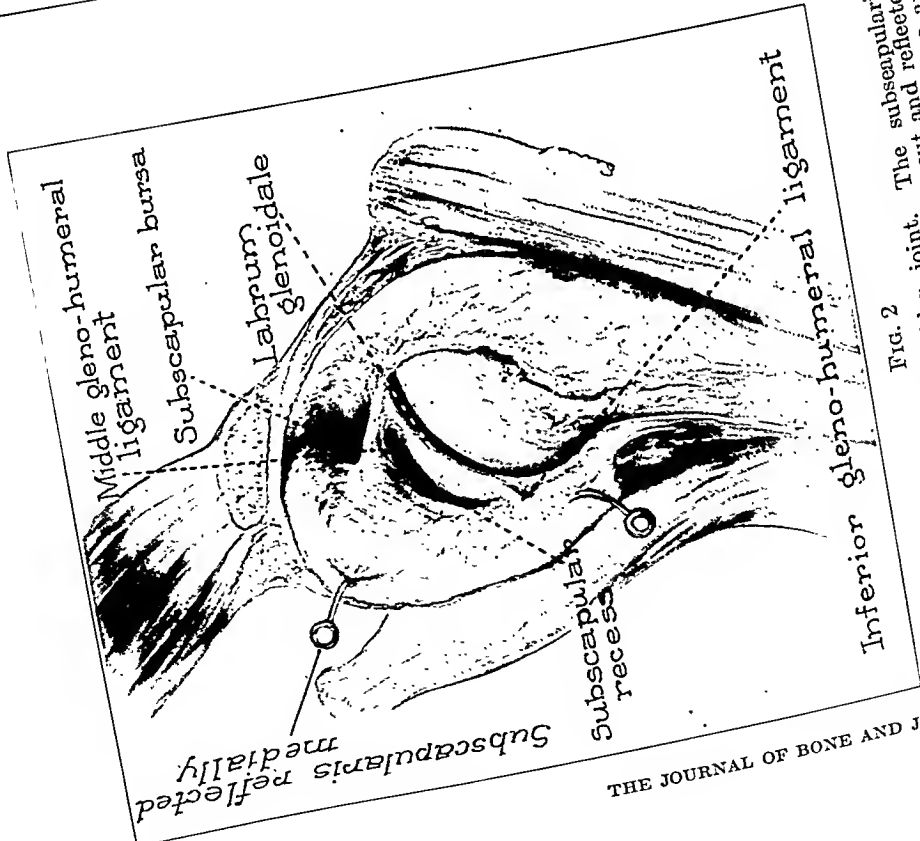


FIG. 2
The subscapularis tendon, together with the capsule, has been cut and reflected medially, exposing the openings of the subscapular bursa and subscapular recess.

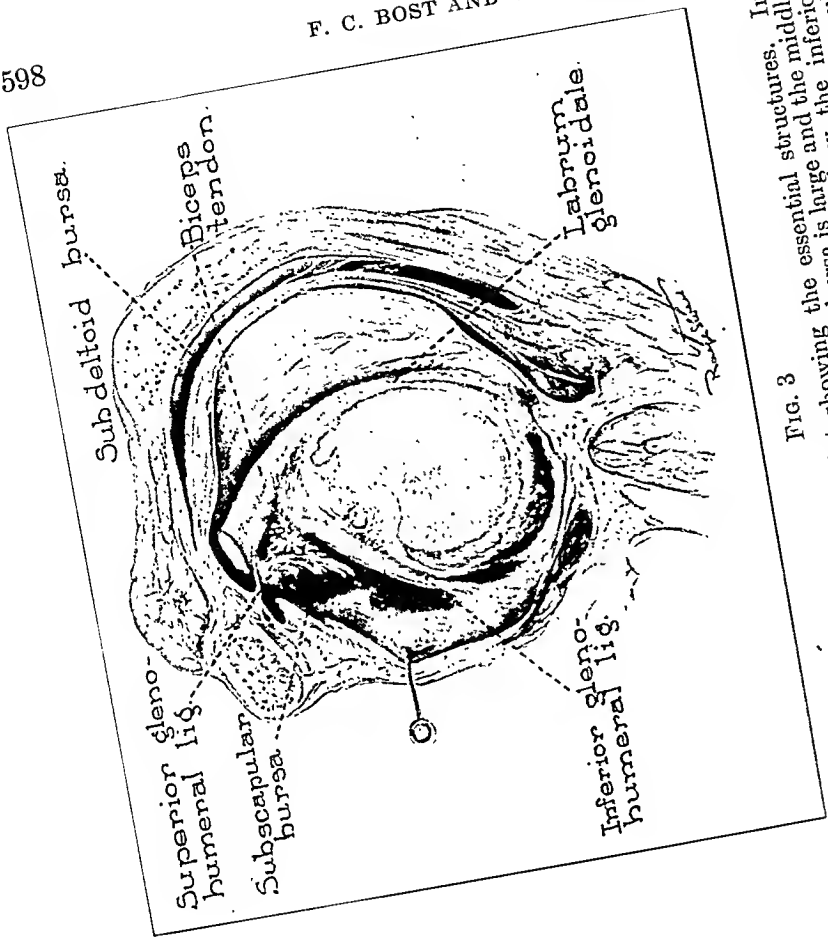


FIG. 3

Interior view of shoulder joint showing the essential structures. In this specimen the opening of the subscapular bursa is large and the inferior gleno-humeral ligament is absent. Note particularly how the antero-inferior portion of the capsule anchors the labrum glenoidale.

marked by the superior glenohumeral ligament, and is constant in its anatomical arrangement. The lower border of the aperture is, however, more variable. When the bursal aperture is small, it is bounded below by a subsynovial capsular thickening, known as the middle glenohumeral ligament, and the furrow between the labrum glenoidale and the capsule extending down to the inferior ligament may, in some cases, reach a depth of from twelve to fifteen millimeters, thus forming a recess opposite the lower fibers of the subscapularis muscle, and functionally supplementing the true bursa. When the middle glenohumeral ligament is absent or insignificant, the aperture is larger and may reach the inferior glenohumeral ligament which then constitutes its inferior boundary.

The subscapular bursa and the frequent occurrence of an additional subscapular recess below the aperture of the subscapular bursa prevent any intimate attachment between the capsule and the labrum glenoidale, except through the medium of the glenohumeral ligaments. This anatomical arrangement deprives the labrum of any capsular support on the anterior portion.

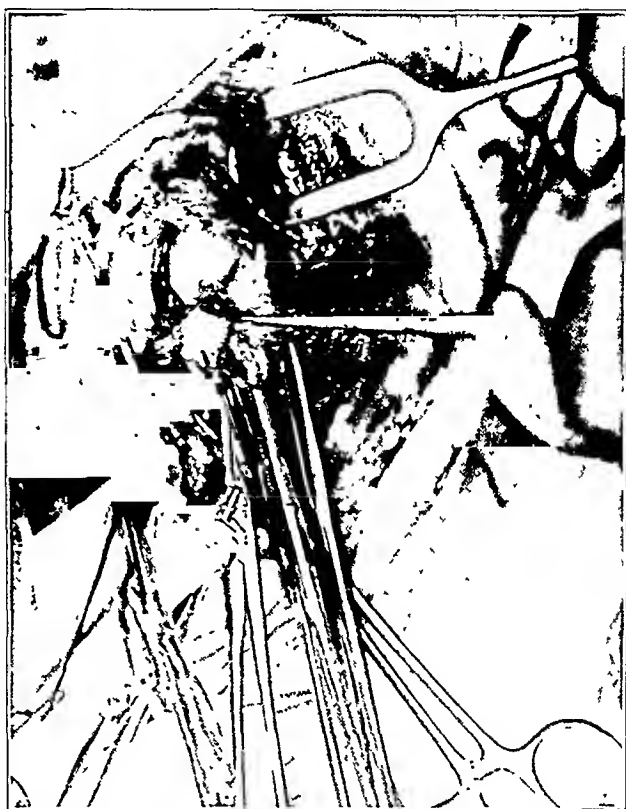


FIG. 4

Case 5. Exposure of shoulder joint at operation. The subscapularis muscle has been reflected medially. The capsule, torn at the glenoid rim, has been reflected laterally. The labrum glenoidale is markedly frayed. The eburnated, eroded, and flattened glenoid rim is evident.

PATHOLOGICAL FINDINGS AT OPERATION

In each of the ten cases, the subscapularis was readily identified at operation, but no abnormality was noted. In several cases it was obvious that an anterior dislocation was present. In one instance, as the tendon of the subscapularis was followed laterally, a number of small rice bodies were found lying below the lesser tuberosity, medial to, but not connected with, the biceps tendon.



FIG. 5-B

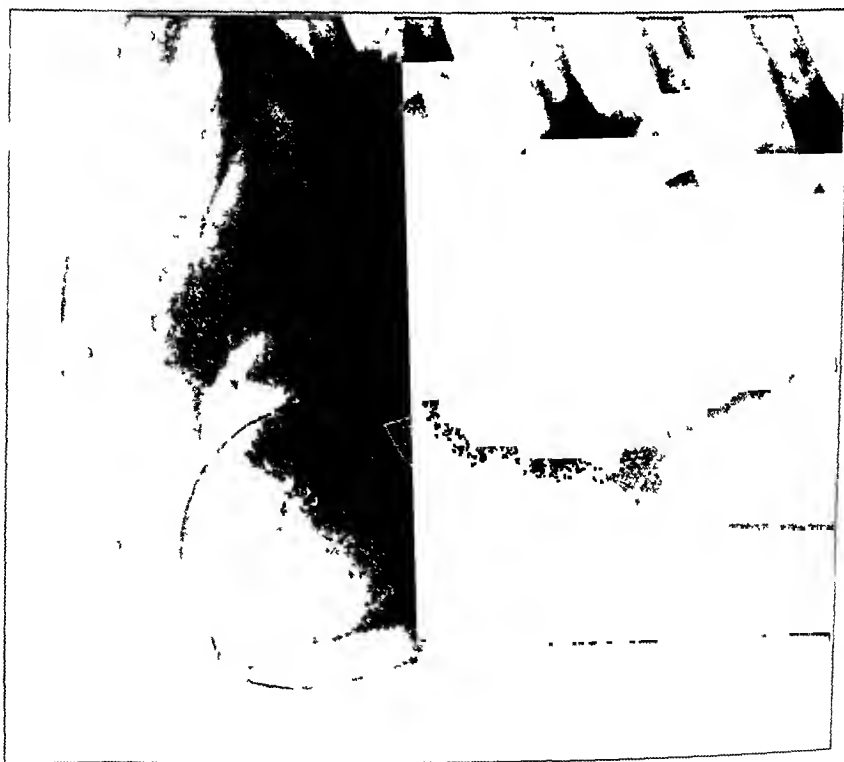


FIG. 5-A

Fig. 5-A: Case 8. External rotation. The head of the humerus appears to be normal.
 Fig. 5-B: Internal rotation. The posterolateral defect appears as a flattening and irregularity on the superolateral aspect of the head.



Fig. 6-B



Fig. 6-A

Fig. 6-A: Casc 5. External rotation. The contour of the head of the humerus appears to be normal. The location of the defect is indicated by an area of increased density.

Fig. 6-B: Internal rotation. The defect is apparent with sharp vertical walls. A loose fragment lies at the base of the defect.



FIG. 7-A

Case 6. External rotation. The posterolateral defect in the humeral head is not apparent.



FIG. 7-B

Internal rotation. The posterolateral defect appears as a notching of the superior articular surface of the head.

Incision of the subscapularis tendon near its insertion into the lesser tubercle of the humerus requires extreme care. While the more tendinous superior portion can be readily identified, more inferiorly the musculotendinous fibers spread out to become attached below the tubercle for a distance of from two to three centimeters; but before the subscapularis reaches the humerus, it inserts directly into and blends with the capsule of the shoulder joint. For this reason the tendon should be incised two centimeters from its bony attachment. Even then the intimate blending of tendon and capsule makes it difficult to separate the two. In seven of



FIG. 8

Case 5. Irregularity of the glenoid rim with proliferation of new bone about the scapular neck is demonstrated. The dense area in the head indicates the postero-lateral defect.

these cases, the capsule was incised as the tendon was cut. When the dislocation was not already present, incision of the tendon released the head of the humerus, so that it rotated externally and dislocated.

As the subscapularis tendon was reflected medially, it could be separated from the capsule, though in some cases sharp dissection was necessary. Once the glenoid rim was reached, it was easy to retract the subscapularis medially, owing to the absence of any attachment to the scapular neck.

Reflection of the subscapularis allowed inspection of the capsule of the anterior portion of the shoulder joint and of the subscapular bursa. The superficial wall of the bursa was reflected with the subscapularis on all but three occasions, allowing direct vision of the joint through the bursal opening.

In six patients, vertical capsule tears were evident at or near the glenoid rim. Some of these openings extended from the superior to the inferior poles of the glenoid cavity; while, in the three instances in which the subscapularis bursa was not opened, the rents were from one to two centimeters in length, and were located in the inferior portion of the capsule. In addition to these tears, redundant capsular pockets lay

inferiorly to the glenoid rim in three patients. Through these capsular openings, the glenoid rim was seen in each case to be denuded of the fibrocartilaginous labrum. In four, the capsule and the labrum were avulsed in mass from the entire extent of the antero-inferior glenoid margin and lay together, collarlike, over the head of the humerus. In two others, the labrum was so split and frayed that it was hardly distinguishable, and the glenoid rim was denuded. The proximal portion of the capsule medial to the rents was elevated from the neck of the scapula. In four patients, no rent in the anterior capsule was detected, but a detachment of the antero-inferior capsule and labrum was present. This was readily demonstrated by passing a Kocher dissector deep into the capsule over the bare glenoid rim and along the scapular neck. In these four cases, the capsule was incised vertically at the glenoid rim. In two, the labrum glenoidale was retracted medially over the scapular neck; while in the other two it was found detached and lying just lateral to the glenoid rim. As in the first group of six cases, the detachment of the labrum glenoidale was wide and virtually bipolar in extent.

Other abnormalities noted within the capsule were the presence of small rice bodies in two shoulders and, in Case 5, a loose, cartilaginous body, 2.5 by 1.0 by 0.5 centimeters in size, which was present anteriorly. Although the origin of this loose body was not definitely proved, it was thought to have originated from the posterolateral defect of the humeral head described later (Fig. 4).

Glenoid Rim

In all of the cases the glenoid rim was abnormal in appearance. The changes consisted of erosions, irregular disintegration of the cartilage, and rounding off of the bony rim. The edges were eburnated, irregular, and a bony overgrowth was present in some instances. In Case 3 fibrillation of the cartilage and eburnation were extensive, and the presence of small loose rice bodies was a prominent feature. In Case 5 a large irregular defect on the antero-inferior rim suggested an old fracture of the bony margin. This case was associated with a large intracapsular cartilaginous loose body, described above, which did not fit, nor is it believed to have had origin from this defect. In Cases 6 and 10, extensive flattening, eburnation, and cartilaginous erosion of the antero-inferior portion of the glenoid cavity were very evident. In Case 10 the glenoid cavity was extremely narrow in its lower third, suggesting the loss of bone substance.

In several instances the loss of the normal bluish-white appearance of the glenoid surface evidenced the presence of attritional changes in the cartilage.

The Head of the Humerus

Two patients showed attritional changes in the cartilage of the head of the humerus, with some fibrillation on the anterior margin. One patient had erosive changes about the lesser tuberosity.



Fig. 9

Anterior and posterior views of the humeral head. Note the typical defect which occupies the posterior articulating surface of the humeral head.

The anterior approach to the joint does not permit visualization of the posterior aspect of the humeral head, and posterior exposure of the humeral defect was not employed.

Roentgenographic Findings

In every instance roentgenographic studies of the patients with recurrent dislocation showed the presence of an unquestionable defect in the posterior aspect of the head of the humerus. These changes varied from easily identified cystic areas, through flattening and irregularity, to a marked notching, involving as much as one-third of the posterior portion of the head of the humerus (Figs. 5-A, 5-B, 6-A, 6-B, 7-A, and 7-B).

In addition to the defects in the humeral head, four patients presented roentgenographic evidence of the stubbing, lipping, and bone proliferation of the antero-inferior glenoid margin (Fig 8). These changes were verified later at operation.

DISCUSSION

A detailed account of the findings has been presented above, because of the conflicting ideas concerning the essential pathological changes of recurrent dislocation of the shoulder. Bankart, alone, recognized the constant presence and great significance of the tear of the labrum glenoidale.

All of the other conditions encountered in these patients have been described and discussed by many others. Neither these observations nor the authors' experiences substantiate Bankart's opinion that the tear of the labrum is the sole lesion in recurrent dislocation. Nevertheless, in

inferiorly to the glenoid rim in three patients. Through these capsular openings, the glenoid rim was seen in each case to be denuded of the fibrocartilaginous labrum. In four, the capsule and the labrum were avulsed in mass from the entire extent of the antero-inferior glenoid margin and lay together, collarlike, over the head of the humerus. In two others, the labrum was so split and frayed that it was hardly distinguishable, and the glenoid rim was denuded. The proximal portion of the capsule medial to the rents was elevated from the neck of the scapula. In four patients, no rent in the anterior capsule was detected, but a detachment of the antero-inferior capsule and labrum was present. This was readily demonstrated by passing a Kocher dissector deep into the capsule over the bare glenoid rim and along the scapular neck. In these four cases, the capsule was incised vertically at the glenoid rim. In two, the labrum glenoidale was retracted medially over the scapular neck; while in the other two it was found detached and lying just lateral to the glenoid rim. As in the first group of six cases, the detachment of the labrum glenoidale was wide and virtually bipolar in extent.

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FIG. 11

Photograph of the externally rotated and slightly abducted humerus, articulated with the scapula. The defect on the humeral head lies opposite the glenoid fossa and the anterior glenoid rim tends to fall into the defect, causing the humerus to slip forward.

A great deal has been written regarding the anterior capsule and the subscapularis. Since the dislocations occur through the antero-inferior part of the joint, Thomas believed that there was an anterior herniation of the capsule following dislocation. He reviewed the literature and discussed in detail the reports concerning capsule tears, relaxation of the capsule, and stripping of the capsule from the glenoid margin. Stimson, and Burrell and Lovett likewise discussed the findings of earlier investigators. Since these discussions, the chief additions have been made by Gallie and LeMesurier who emphasized the importance of the tearing of the capsule and the inferior glenohumeral ligament from the glenoid rim, and by Cotton and Morrison who pointed out the deficiency of the anterior capsule of the shoulder joint. Reich and Henderson, among others, questioned the sufficiency of the subscapularis, although no exact description of this condition has been given. In 1891, Sick, quoted by Thomas²⁹ reported a case in which "... the glenoid cartilage was destroyed from the lower end of the cavity up to the insertion of the long head of the biceps". Thomas²⁹, after experiments on cadavera, stated that a disturbance of the glenoid cartilage might be expected. Except for Bankart's report² however, no further mention of the labrum glenoidale has been found in the literature. Thomas, in his discussion of the operative findings through a posterior axillary approach³¹, reported that by palpation "a small piece of bone may be detected in the antero-inferior part of the joint, loosely attached by a fibrous pedicle or

imbedded in the capsule"; but he did not identify this as the labrum glenoidale.

Of all the investigators, Thomas³¹ and Reich appear to have been the first to attempt an integration of the pathological findings in order to explain the etiology of recurrent dislocation. Reich, from his study of cadavera and macerated skeletons, established the coexistence of a group of changes contributing to dislocation of the shoulder. These, in his opinion, consisted of the bone defects and a functional deficiency in the subscapularis with a subscapularis bursitis.

Finally Bankart, by pointing out the constant occurrence of the tear of the labrum glenoidale, made it possible for the first time to link together the complete picture of the pathological changes attendant upon recurrent dislocation.

Adding to these studies, the authors' observations lead to the conclusion that the pathological changes are:

1. Detachment of the labrum glenoidale and the anterior capsule of the shoulder joint.
2. A defect in the posterolateral portion of the head of the humerus.
3. Erosion or fracture of the glenoid rim.

This concept of the combined pathological changes in recurrent dislocation permits an understanding of the etiology of this condition.

The Mechanism of Production of Recurrent Dislocation

A great disparity exists in the description of various authors as to the precise mechanism of anterior dislocation of the shoulder. This is understandable, because the combination of pathological changes exhibited by these patients has not been appreciated.

As a result of the present studies, the authors feel that the essential mechanism is one in which the head of the humerus is driven forward onto the glenoid rim by a force applied either directly to the shoulder, or indirectly through leverage of the arm by abduction in internal rotation or by hyperextension. At this stage there must be initial tearing or stretching of the anterior capsular attachments. As the head is carried farther forward, the arm must pass into a position of abduction and external rotation to bring the posterosuperior aspect of the humeral head into contact with the edge of the glenoid fossa. The extent of injury to the labrum glenoidale and to the lip of the glenoid fossa, together with the production of a compression or sheering fracture of the head of the humerus, will depend upon the force with which the head is thrust against the anterior glenoid lip. If this force is great, the labrum is wiped from its attachments, and the sharp edge of the glenoid rim digs into the posterior aspect of the head of the humerus, depressing or scooping out a bone defect, with or without chipping of the glenoid lip. This is conceived to be the initial damage, and the ease with which redislocation occurs depends upon the extent of this initial injury.

A recurrent dislocating shoulder is, therefore, one which has sustained

an avulsion of the labrum glenoidale and capsular anchorage, with stubbing of the glenoid rim and some destruction of the posterosuperior aspect of the articulating surface of the humeral head. In such cases the head is supported only by the shallow concavity of the glenoid fossa, because the detached labrum and capsule offer no resistance to the dislocating force. When the arm is abducted and externally rotated—the position most likely to lead to redislocation—the defect in the humeral head lies opposite the glenoid fossa, and the normal locking effect of the convex surface of the head is lost. Should the structures attached to the anterior glenoid rim be avulsed, there is nothing to prevent the head of the humerus from sliding forward and dislocating (Fig. 11).

If the shoulder is dislocated habitually, secondary changes appear attendant upon the development of a traumatic arthritis. These changes are proliferation of bone about the scapular neck, eburnation of the glenoid rim, production of loose bodies, synovial thickening, and cartilaginous disintegration.

Report of Operative Results

The great variety of operations designed to check the tendency toward a recurrence of the dislocation indicates a general lack of understanding in regard to the causes of the disorder. It is not the authors' intention to discuss or compare the various operative procedures used in recurrent dislocation. It may be pointed out, however, that a proper conception of the etiology and pathological changes of this condition should lead to an improvement in the methods of operative repair to be employed for its relief.

The operation used by Bankart has proved to be an excellent one in the experience of its originator. It is a satisfactory procedure in that it allows exposure of the lesion primarily responsible for the dislocation. It must be understood that actual replacement of the labrum glenoidale is not always possible, for this structure is sometimes frayed and relatively non-existent. It is, however, possible to fasten the capsule securely to the glenoid rim from which it has been stripped.

The authors' limited experience indicates that the use of this operation has certain disadvantages,—namely, the technical difficulties of suturing the capsule and labrum to the deeply placed glenoid rim, and the relatively poor and thinned-out capsular structure sometimes found at the site for resuture. This latter condition has been circumvented by suturing some of the posterior surface of the subscapularis to the glenoid rim.

Eight of the ten patients (Table I) have been followed for from eighteen months to over three years,—a sufficient time to permit an evaluation of results. Seven patients have had no recurrences, although one of them was observed for only seven months. At the end of that time, however, he had a full range of motion and had engaged in competitive sports. All of these patients were muscular males engaged in the most vigorous occupations, and all have reported excellent function of the

TABLE I
RÉSUMÉ OF TEN CASES

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Case No.	Sex and Age at Operation	Occupation	Initial Trauma	Date of Operation	Operative Findings			Roentgenographic Findings		Final Result
					Labrum Glenoidale	Glenoid Rim	Capsule	Humeral Head	Glenoid	
1 E. A.	Male 35	Fireman	1937 Fall; sudden forced abduction.	Sept. 14, 1938	Complete antero-inferior detachment; lateral displacement.	Roughened; eroded; eburnated.	Torn at glenoid rim.	Flattened posterolateral superior portion.	Negative	39 months postoperative; no recurrence; no restriction of motion. Hard manual work.
2 W. B.	Male 16	Student	1936 Tackled in football.	Nov. 22, 1938	Complete antero-inferior lip detached; lateral displacement.	Eburnated; cartilage eroded; lipping.	Torn at glenoid rim.	Cystic changes; flattened and irregular posterolateral superior portion.	Negative	37 months postoperative; no recurrence; no restriction of motion. All types of heavy labor.
					Complete antero-inferior detachment; deflected laterally.	Eroded; cartilage eroded; proliferation.	Torn at glenoid rim; rice bodies present.	Irregular; flattened; defect of 1/3 of posterior head with loose fragments and proliferation; cystic changes.	Lipping and proliferation; question of fracture of rim.	30 months postoperative; no recurrence; no restriction of motion. Heavy labor and ship riveting.
3 J. L. Right	Male 36	Construction worker	1929 Scuffling.	June 16, 1939	Complete antero-inferior detachment; deflected laterally.	Eburnated; cartilage eroded.	Not torn at rim; rice bodies medial to biceps tendon; mild synovitis.	Cystic change in posterolateral portion.	Negative	7 months after operation; no recurrence. Had played college basketball.
4 P. I.	Male 22	Student	1937 Wrestling; extreme abduction and flexion.	July 11, 1939	Complete antero-inferior detachment; medial displacement.	Eburnated; cartilage eroded.				

5	J. L. Left	Same patient as Case 3	Construction worker	1930 Cranking truck.	Oct. 11, 1939	Complete antero-inferior detachment with marked fraying.	Eburnated; cartilage eroded; flattened; large loose body.	Torn at glenoid rim; marked synovitis; loose body.	Large defect; flattened.	Marked proliferation; question of fracture.	26 months postoperative; no recurrence. no restriction of motion. Heavy labor and ship riveting.
6	J. R.	Male 26	Elevator operator (Epileptic)	1933 Scuffling.	Oct. 16, 1939	Complete antero-inferior detachment with fraying; lateral displacement.	Eburnated; flattened; scarring of cartilage.	Torn at glenoid rim.	Large defect scooped out of posterolateral margin; $\frac{1}{3}$ eroded.	Negative	26 months postoperative; recurrence 3 weeks after operation and repeatedly thereafter, due to inadequate repair and immobilization.
7	J. B.	Male 18	Student	1938 Abduction; external rotation; football injury.	May 2, 1940	Complete antero-inferior detachment; medial displacement.	Eburnated; roughened.	Ripped from rim; no rent.	Flattened; irregular with question of a detached portion.	Negative	20 months postoperative; no recurrence; no restriction of motion. Shipyard worker.
8	H. B.	Male 20	Student	1937 Football line play.	July 14, 1940	Complete antero-inferior detachment; lateral displacement.	Eburnated; rounded; irregular.	Ripped from glenoid; no rent.	Flattened and irregular posterolateral portion.	Lipping and sclerosis of rim.	17 months postoperative; no recurrence; no restriction of motion. Machinist; heavy work.
	R. H.	Male 21	Student	1936 Skiing; abduction; external rotation.	May 21, 1941	Complete antero-inferior detachment; lateral displacement.	Roughened with lipping.	Stripped from scapular neck; no rent.	Concavity of $\frac{1}{2}$ of posterolateral surface; sclerosis.	Negative	7 months postoperative; no recurrence; no restriction of motion. Heavy machine work.
		Male 40	Forester	1919 Slipped and fell.	Nov. 20, 1941	Complete antero-inferior detachment; lateral displacement.	Eroded; lipping.	Rent in capsule.	Cystic area; flattened; irregular.	Lipping	6 weeks postoperative; partial immobilization.

shoulder. The eighth patient, an epileptic, has had repeated dislocations, beginning three weeks after operation. This failure can be attributed to the unsatisfactory repair. It is interesting to note that the head of the humerus showed a large defect. Of the remaining two patients, one is doing heavy machine work, seven months after operation. The other was operated upon only six weeks ago.

CONCLUSIONS AND SUMMARY

The principle purpose of this paper has been to extend the observations of Bankart on recurrent dislocation of the shoulder joint and to present a triad of pathological findings which the authors consider essential to the etiology of this condition. This triad consists of:

1. Detachment of the labrum glenoidale and the anterior capsule of the shoulder joint.
2. A defect in the posterolateral portion of the head of the humerus.
3. Erosion or fracture of the glenoid rim.

The findings indicate that recurrent dislocation of the shoulder is likely to be associated with far more extensive damage to the joint than has been heretofore disclosed. The complexities of the findings necessitate not only a more complete study, but also special examinations of the individual case before an accurate prognosis can be arrived at and rational therapy instituted. The surgical procedure adopted in the treatment of these cases must be governed by a full appreciation of the extent of the underlying pathology, if a successful outcome is to be anticipated.

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ANTERIOR DISLOCATION OF THE SHOULDER

THE RÔLE OF THE ARTICULAR CAPSULE

BY TOUFICK NICOLA, M.D., MONTCLAIR, NEW JERSEY

From the Division of Orthopaedic Surgery, Mountainside Hospital, Montclair

This report is limited to the rôle of the capsule in the dislocated shoulder, and to the treatment of acute and recurrent dislocations. Complicated and old unreduced dislocations, and nerve injuries are not included.

MECHANISM OF PRODUCTION OF ANTERIOR DISLOCATION

In the majority of cases, anterior dislocations of the shoulder are produced by a fall or blow upon the abducted arm. If the abduction force continues to produce hyperabduction, the head of the humerus is forced down, so that it rests upon the inferior portion of the capsule. At this point a traction force comes into play, and the head of the humerus begins to lift out of the glenoid cavity. This is due to the concavity of the glenoid cavity and to the abducting force. The capsule then begins to separate from the neck of the humerus when the humerus is at 105 degrees of abduction in relation to the glenoid cavity. By further abduction and outward rotation, the capsule tears away from the neck of the humerus to such a degree that the head of the humerus is allowed to dislocate. If, on the other hand, a force of impaction is added, with the humerus in 105 degrees of abduction, the labrum glenoidale together with the articular capsule attached to the neck of the scapula are torn, thus allowing the head of the humerus to dislocate.

In none of the cases studied was the capsule torn near the center of the inferior portion, where it is anatomically thinnest.

This report is based on a study of eighty dislocated shoulders,—five fresh acute dislocations, fifty dislocations produced upon fresh cadavera, and twenty-five consecutive recurrent dislocations.

Acute Dislocations

The five patients operated upon for acute dislocation ranged from eighteen to forty-eight years of age.

CASE 1. A high-school student, aged eighteen, fell while playing football. When giving his history, he was quite definite that his shoulder dislocated after he fell on his elbow with his arm out from the side of his body. At operation, the capsule was found to have been torn away from the anterior and inferior aspects of the neck of the scapula for about two inches. The labrum glenoidale was also ruptured. In this case the force was one of abduction plus impaction.

CASE 2. A prize fighter, aged twenty, threw a punch with his left hand which struck the side of the head of his opponent who was coming in fast to force the fight. At operation the capsule was found to have been torn away from the anterior and inferior aspects

of the neck of the humerus up to the subscapularis tendon. In this case the force was one of hyperabduction.

CASE 3. A school teacher, aged thirty-three, had her shoulder stretched under anaesthesia to increase motion for so-called chronic adhesive bursitis or periarthrititis. After stretching, which was accompanied by the usual sounds, the arm was placed in hyperabduction, with the hand held to the head of the bed. The next day, the patient complained of severe pain. A roentgenogram showed a subcoracoid dislocation. At operation, the capsule was found to have been torn away from the anterior and inferior aspects of the neck of the humerus up to the subscapularis tendon.

CASE 4. A housewife, aged forty, was admitted to the Hospital for a stretching to increase motion at the shoulder for so-called chronic adhesive bursitis or periarthrititis. Before the shoulder was stretched, the joint was exposed down to the capsule, the arm was then abducted, and it was noted that at 80 degrees the capsule began to tear away from the neck of the humerus, with the usual sounds. As abduction was continued, the capsule tore away from the anterior and inferior aspects of the neck of the humerus and permitted dislocation of the head of the humerus.

CASE 5. A farmer, aged forty-eight, fell between two trucks, his arm being forced into hyperabduction. This patient was admitted to the Hospital, and was operated upon before his shoulder was reduced. At operation, the capsule was found to have been torn away from the anterior and inferior aspects of the neck of the humerus. In this case the subscapularis tendon was also torn away from its attachment to the humerus. The glenoid cavity was covered by the capsule and subscapularis tendon. Attempts to reduce the dislocation by traction and Kocher method failed. Therefore, the head of the humerus could not have been replaced by a closed reduction. After reduction the capsule was reattached to the neck of the humerus.

Dislocations on Fresh Cadavera

This study was made on fifty acute dislocations of the shoulder produced on twenty-five fresh cadavera. The capsule was torn either from the neck of the humerus or the neck of the scapula, depending upon the direction of the applied force.

A force applied in continued abduction tears the capsule from the neck of the humerus. A force started in abduction of 90 to 105 degrees, and then supplemented by impaction, tears the capsule from the neck of the scapula.

Recurrent Dislocations

In the first eight cases in this series of twenty-five consecutive cases of recurrent dislocations, the shoulder was first redislocated under anaesthesia before the exposure was made. In the remaining seventeen cases, the capsule was examined without dislocation, by first cutting a strip of the capsule just above the tendon of the long head of the biceps, three-eighths of an inch wide, beginning at the distal edge of the transverse humeral ligament, and exposing it up into the coracohumeral ligament and supraspinatus tendon. The long head of the biceps was divided three-quarters of an inch distal to the lesser tuberosity. A long curved clamp was placed in the joint and the capsular attachments were explored.

In nineteen cases the capsule was found to have been torn from the neck of the scapula; in six the capsule was found to have been torn from

the neck of the humerus. In these cases the edge of the torn capsule was incorporated in a very thin fibrous membrane, which made it difficult to see the edge of the torn capsule.

In 100 per cent. of the cases in this series of recurrent dislocation of the shoulder, the recurrence followed a traumatic dislocation produced by sports. The shoulders were immobilized, after the initial dislocation and reduction, for periods varying from two to five weeks. It was possible, when a history could be obtained of the trauma, to predict the location of the tear of the capsule,—if the trauma was hyperabduction, then the capsule was torn from the neck of the humerus; if hyperabduction with impaction, then the capsule was torn from the neck of the scapula.

TREATMENT

In acute dislocations in young, vigorous individuals who expect to return to active sports, the author believes that the shoulder should be operated upon at the time of the first dislocation. The operation should consist of reattaching the capsule to the neck of the humerus or the neck of the scapula, depending upon the location of the tear. In addition, the long head of the biceps should be passed through the head of the humerus at least one-half inch from the edge of the articular cartilage.

In recurrent cases, the capsule should be explored to determine the location of the tear. After repairing this, the shoulder should be reinforced with the long head of the biceps, together with a strip of the capsule which lies above it.

CONCLUSIONS

The location of the tear of the articular capsule varies in different cases, and depends upon the force,—hyperabduction tears the capsule from neck of the humerus, and hyperabduction plus impaction tears it from the neck of the scapula.

Open operation on initial acute dislocations in young individuals who expect to return to active sports will give a higher percentage of cures.

MACRODACTYLY AND ASSOCIATED PERIPHERAL NERVE CHANGES

BY BEVERIDGE H. MOORE, M.D., CHICAGO, ILLINOIS

Macroductyly or megalodactyly is one of the rarer forms of congenital deformity seen in orthopaedic clinics. It is in reality a form of localized hypertrophy, but it seems especially interesting on account of the peculiarly bizarre deformities it often produces. The literature dealing with the condition is not abundant, and consists mainly of reports of single cases. More of the cases have been reported from the Latin countries—particularly from South America—than in the English literature. Whether this is of any significance as indicating relative frequency in geographical location is doubtful, since most of the reports are of single cases. None of the patients in this series were of Latin extraction, and, judging from the names, all but one were of northern European stock. Of this series of five cases, one was seen at Northwestern University Medical School, and four at the Shriners' Hospital for Crippled Children.

For the sake of brevity a detailed description of the deformities in each case is not given. The illustrations afford a much more definite idea of the appearance of the affected member.

CASE 1.* E. M., a Filipino male, aged twenty years, was seen at Northwestern University Medical School, and was admitted to Wesley Hospital on July 26, 1920.

He complained of difficulty in opening and closing the two middle fingers of his right hand. It was noted that these two fingers were considerably larger than the normal proportion and that there was a distinct bulging of the palm extending into the wrist. The patient said the fingers had been enlarged as long as he could remember. The skin of the palmar surface of the hand was coarse in texture, thickened, and somewhat wrinkled. The difficulty in opening and closing the fingers was ascribed to obstruction of the flexor tendons at the annular ligament of the wrist. At operation the tendons were found to be normal, but the median nerve presented a marked fusiform enlargement which felt corded and fibrotic to touch. On opening the sheath, the fasciculi were found to be enlarged, corded, and fibrous. A small portion of one fasciculus was removed for microscopic examination. The annular ligament was closed *under* the nerve tumor, and the skin and fascia *over* it. This completely relieved the difficulty in opening and closing the fingers.

Examination of the biopsy specimen showed an enormous proliferation of fibrous tissue apparently from the endoneurium. This fibrous tissue completely overshadowed the nerve tissue. The diagnosis by Dr. Zeit was "neurofibroma of the *Rancken-neuroma* type".

CASE 2. R. K., a white male, aged twenty months, was seen on September 30, 1938, at the Shriners' Hospital.

The deformity was a marked overgrowth of the three outer toes of the left foot and the two outer toes of the right foot (Figs. 2-A and 2-B). The patient was one of twins, the other (a girl) had died shortly after birth. There was no history of any other deformities on either side of the family. The deformity had been present at birth, but the disproportion in the size of the toes had increased rapidly with growth. In addition

* Case 1 has been previously reported by the author.

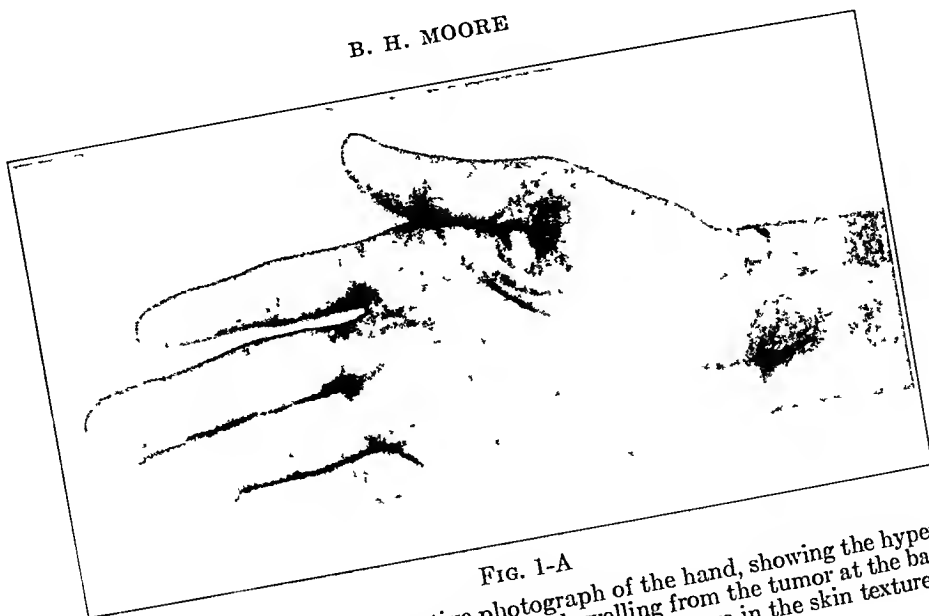


FIG. 1-A

Case 1. E. M. Postoperative photograph of the hand, showing the hypertrophy of the second and third fingers and swelling from the tumor at the base of the palm just above the line of incision. The change in the skin texture is seen down the middle of the palm.

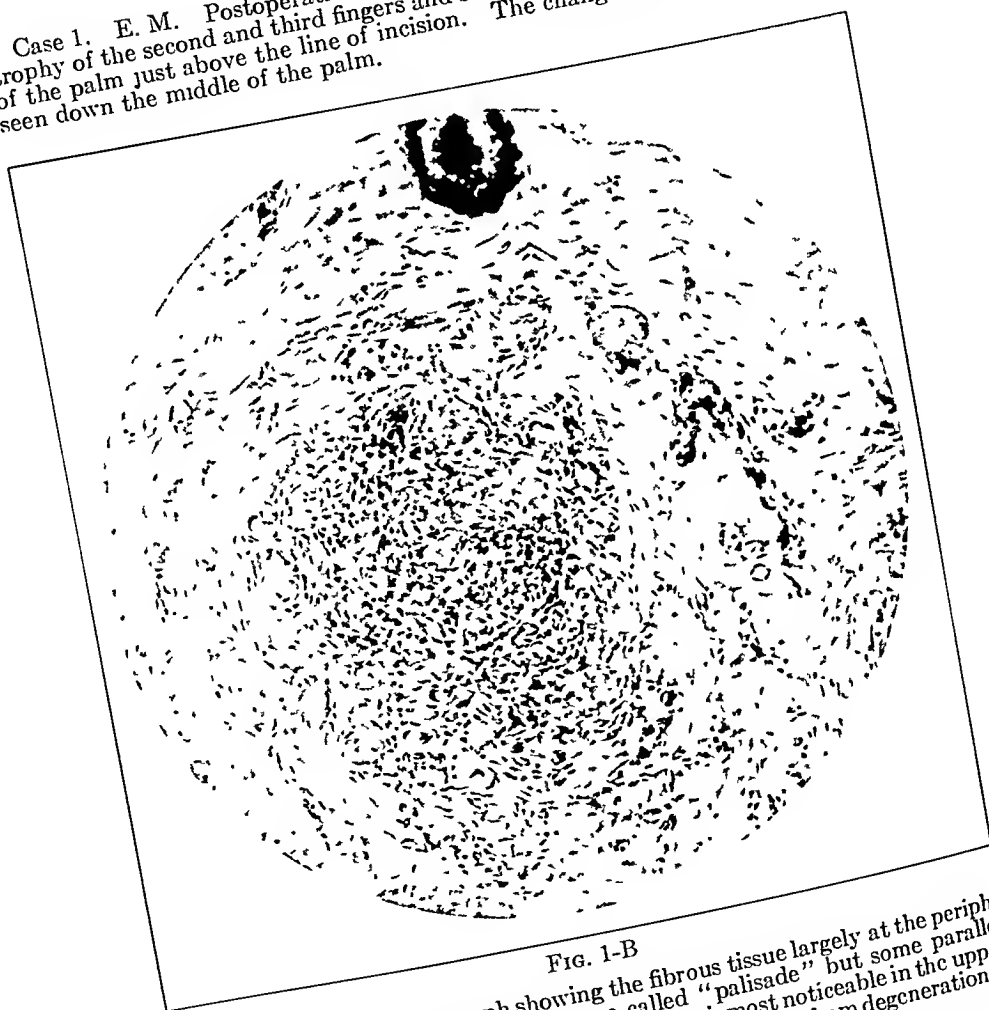


FIG. 1-B

Low-power photomicrograph showing the fibrous tissue largely at the periphery of the field, with very little of the so-called "palisade" but some parallel arrangement of the elongated and narrowed nuclei, most noticeable in the upper left quadrant. The few vacuolations seen are presumably from degeneration of nerve fibers. This is an old, mature type of tumor.

to the deformities of the feet, there were several large non-pedunculated fatty tumors present on the trunk. There was one definite, but lightly pigmented, *café au lait* spot on the right buttock.

Roentgenograms showed that the hypertrophy involved the bones of the affected toes, including the metatarsals as well as the soft tissues. The femur and the tibia and fibula of the left leg were slightly larger than those of the right.

Operation: A partial amputation including the fifth metatarsal and the fourth and fifth toes was done on the right foot on October 18, 1938. A similar operation, but including the third toe, was done on the left foot on January 10, 1939.

Peripheral Nerve Pathology: In this case it was very difficult to find a nerve in the amputated portion. After several attempts a complete cross section of one of the toes was made. In this a nerve composed of several fasciculi was found. In all of these there was a marked infiltration of fibrous tissue with an almost complete absence of axis cylinders (Figs. 2-D and 2-E).

CASE 3. E. B., white male, aged one year, was seen at the Shriners' Hospital on June 3, 1938. The deformity was a marked enlargement of the first and second toes of the right foot (Fig. 3-A). In this case the entire right leg from the hip down was enlarged, but the two toes were much out of proportion even to the enlarged leg. In addition, there was a large purplish naevus over the surface of the leg extending over the buttock and lower back (Fig. 3-B). The left leg also showed patches of the same condition on the outer and posterior region. There were one or two *café au lait* spots on the back,



FIG. 2-A

FIG. 2-B

FIG. 2-C

Fig. 2-A: Case 2. R. K. Showing the deformities of the feet and toes. The entire left leg is slightly larger than the right.

Fig. 2-B: The sole of the left foot. The fifth toe is larger than the normal first.

Fig. 2-C: Back view. Note the lipomatous masses on the back. On the right buttock are two faintly colored, but definite *café au lait* spots.

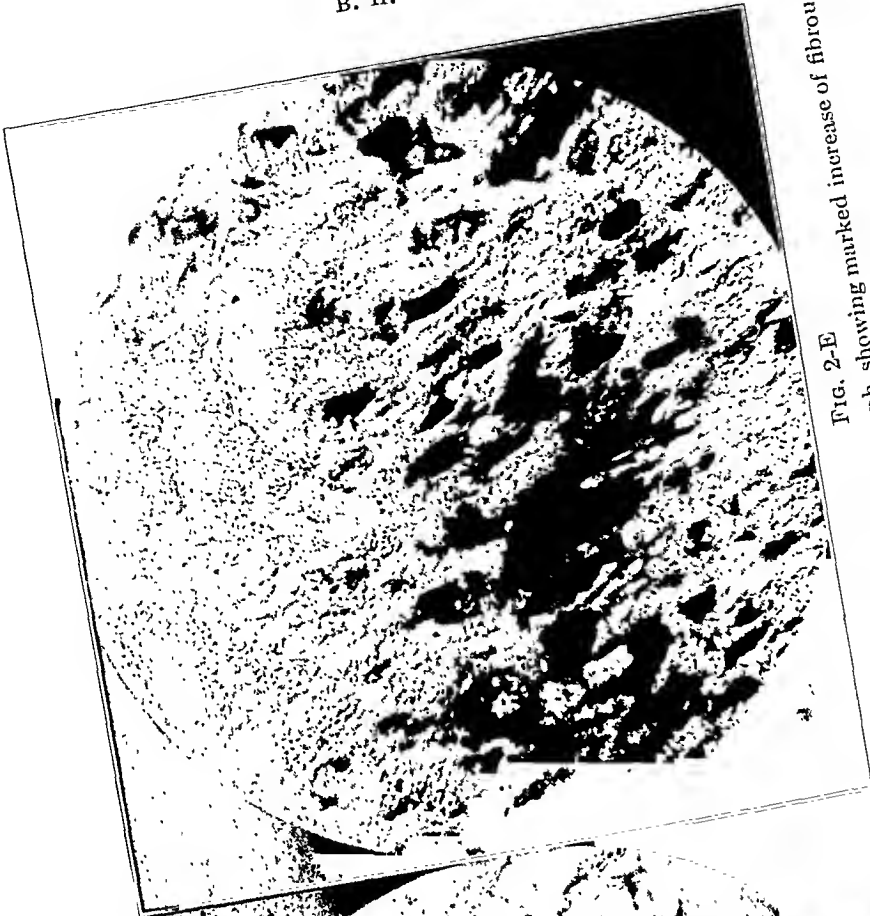


Fig. 2-E
Oil immersion photomicrograph, showing marked increase of fibrous tissue.



Fig. 2-D
Case 2. R. K. Low-power photomicrograph of a nerve fasciculus, showing the general fibrosis.

though they were faintly pigmented. In addition, the mother showed several brownish pigmented areas on her face, and a number of small pedunculated skin tumors suggestive of von Recklinghausen's neurofibromatosis. Two older children were normal. The deformity was present at birth, but it had been increasing rapidly. On account of the extensive naevus formation no operative measures were attempted, except a biopsy on a small cutaneous nerve. This was reported to show an increase in the perineurial and endoneurial fibrous tissue. Unfortunately the tissue block was lost before more than the routine work could be done.

The patient received roentgenotherapy in an attempt to reduce the naevus; little or no result was obtained however. On October 24, 1941, he was again admitted. In the interval of three and a half years he had grown rapidly, and the disproportion between the two legs was not so marked. However, the two toes had grown at a much more rapid rate than the normal ones. The naevus had faded considerably. The *café au lait* spots were still present, and the pigmentation had not increased in them.

Operation: On November 8, 1941, amputation of the second toe and the distal phalanx of the first toe was performed.

Nerve Pathology: In this case also it was very difficult to find a nerve in the hypertrophied subcutaneous tissue, so a complete cross section of the amputated toe was made and sectioned. In this, two nerves with several fasciculi were found. The findings were an increase in the endoneurial nerve tissue. In this case, however, the fasciculi differed quite widely from each other (Figs. 3-C, 3-D, 3-E, and 3-F). In one the fibrous tissue was arranged in interlacing fibrils with almost no definite nerve tissue. This approached the classical picture of a neurofibroma. In another fasciculus the fibrous tissue was much more solid and in areas tended to whorl formation. The nerve fibers in this varied widely from very narrow compressed fibers to a few appearing almost normal. However, the fibrous tissue dominated the picture. In two or three other fasciculi the increase in fibrous tissue was slight, so the picture was that of a relatively normal nerve.

CASE 4. H. H., a white male, aged three years, was seen at the Shriners' Hospital on August 2, 1940.

The deformity was a very marked overgrowth of the first and second toes of the left foot (Figs. 4-A and 4-B). The deformity had been present at birth, but had been increasing ever since. He was the first and only child, and there was no history of any

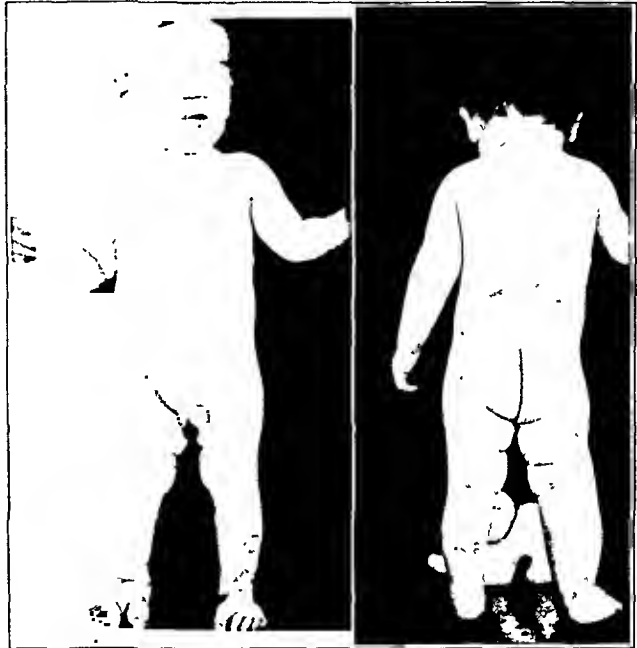


FIG. 3-A

FIG. 3-B

Fig. 3-A: Case 3. E. B. Front view showing the overgrowth of the right leg and the enlargement of the first and second toes. The dark coloration on both legs is naevus formation. Near the costal margin on both the right and left side is a faint *café au lait* spot.



FIG. 3-C

Case 3. E. B. Low-power photomicrograph of one nerve, showing varying degrees of fibrosis in different fasciculi.

FIG. 3-D

High-power photomicrograph, showing some increase in fibrous tissue, but many relatively normal nerve fibers.



FIG. 3-E

Case 3 E. B. Low-power photomicrograph of another nerve, showing definite fibrosis.

FIG. 3-F

Oil immersion photomicrograph of the same nerve, showing almost complete fibrosis. In the upper right quadrant is an area very closely resembling a definite neurofibroma.

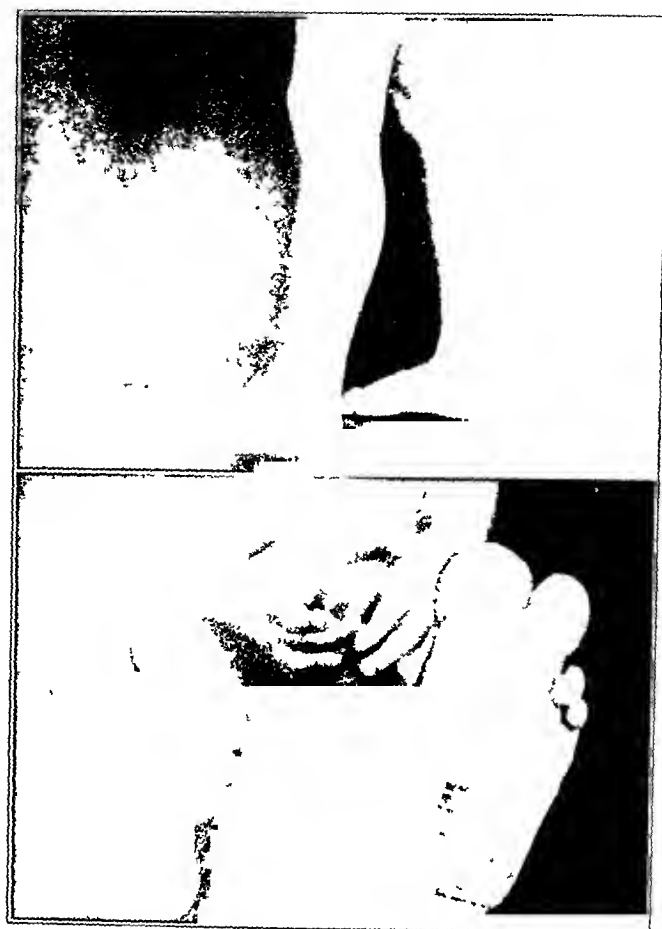


FIG 4-A (Above)

FIG. 4-B (Below)

Fig 4-A (Above): Case 4. H. H. Lateral view of the left foot showing the enlargement of the toes.

Fig 4-B (Below): The soles of both feet, showing the disproportion in the size of the toes.

deformities on either side of the family. One operation (apparently an attempt at epiphyscal arrest in the toe) had been done elsewhere at the age of nine months, but the deformity had continued to increase.

Operation: On September 9, 1940, an attempt was made to reduce the size of the toe by excision of a considerable portion of the skin and subcutaneous tissue. The result of this was unsatisfactory, and an amputation of the first and second toes was done on October 17, 1940.

Peripheral Nerve Findings: Sections showed a very marked increase in the fibrous tissue of the endoneurium (Figs. 4-C and 4-D). The perineurium, also, was markedly thickened. Very few axis cylinders were found in any of the fasciculi. Silver impregnation stains showed that there were nerve elements present, but diminished in number and completely overshadowed by the fibrosis.

CASE 5 M. J. B., a white female, aged two years, was seen at the Shriners' Hospital on November 8, 1940.

The deformity consisted of a moderate enlargement of the third and fourth toes of the right foot. The third toe was much larger than the fourth. The deformity had been present at birth, and the disproportion of the toes had increased at a moderate rate. One other child was normal, and there was no history of deformity on either side of the family.

Operation On February 27, 1941, the third toe, including the head of the metatarsal, was amputated.

Nerve Pathology: Examination of a nerve removed from the amputated toe, showed a marked increase in the fibrous tissue apparently from the endoneurium. The perineurium in this case was not thickened. Axis cylinders were rare, and, where found, the myelin was frequently narrowed, suggesting compression by the fibrous tissues.

Clinical Résumé. In all these cases there was a marked localized overgrowth of one or more digits. This overgrowth involved all the tissues of the affected member,—the skin and nails, the subcutaneous tissue, and the bone. The skin in all of them showed marked thickening



Fig. 4-C

Case 4. H. H. Low-power photomicrograph of a nerve fasciculus, showing a marked increase of endoneurial fibrous tissue.

Fig. 4-D

High-power photomicrograph of a portion, showing almost complete fibrosis. There is a distinct whorl formation of the fibrous tissue.

and changes in texture, the markings being coarse, and the skin itself somewhat wrinkled and dimpled. In the four children, who of course were still growing, the affected digits were growing at a more rapid rate than the normal ones, so that the disproportion was increasing. In two of the cases, the entire leg on the side of the deformity was larger than the normal one. The only other gross deformities associated with the condition were the large lipomata in Case 2 and the naevi in Case 3. In two of the cases there were *café au lait* spots such as are seen in cases of von Recklinghausen's disease in children. In both cases the spots were definite in outline, although the pigmentation was rather faint and might be overlooked on casual examination. In one of these two cases (Case 3) there was also evidence of von Recklinghausen's disease in the mother, which may be regarded as collateral evidence since the condition is frequently hereditary. Attention is called to this finding particularly as its implications will be discussed more fully later.

Pathological Résumé: In Case 1 (the only adult in the series), the

nerve condition was definitely diagnosed, on microscopic examination, as a neurofibroma. In the other four cases (all children) there was a marked similarity in the nerve pathology in all, but none of them were definitely diagnosed as neurofibroma. The most striking and obvious change was the marked increase in the fibrous tissue in the fasciculi. This was entirely out of proportion to the amount of supporting tissue seen in normal nerve sections. This increase in fibrous tissue was mainly endoneurial, but with varying degrees of involvement of the perineurium. The nuclei of the fibrous tissue



FIG. 5-A (Above)

FIG. 5-B (Below)

Fig. 5-A (Above): Case 5. M. J. B. Anterior view showing the deformities of the toes. The small dark area near the middle of the leg is not a typical *café au lait* spot, but it has persisted and may be of that nature.

Fig. 5-B (Below): View of the soles of both feet.



FIG. 5-C

Case 5. M. J. B. Low-power photomicrograph of three nerve fasciuli, showing an increase in fibrous tissue.

FIG. 5-D

Oil immersion photomicrograph of a portion of one fasciculus, showing marked infiltration of fibrous tissue with only slight remains of nerve tissue.

were large and more numerous than in normal nerve tissues,—a probable indication that the fibrosis was progressing. In the sections, the fibrous hyperplasia completely overshadowed the nerve elements present. That nerve elements were present was shown by silver stains. There were also changes in the nerve elements as shown by the van Gieson stain. The axis cylinders were much diminished in number, and in many of the sections the myelin sheath was swollen and vacuolated. Another deviation from normal was the almost complete absence of Schmidt-Lautermann structures in the nerve fibers. A few of these could be found only by careful searching. These findings would seem to be indicative of definite degenerative changes in the nerve fibers themselves. The pathological changes noted may be summed up as an increase in the fibrous elements of the nerve fasciculus, with evidence of degenerative changes in the nerve fibers. The author has been calling these changes fibrotic degeneration. Whether the fibrosis or the degenerative changes are primary is still an open question.

Nageotte states that a nerve fiber losing its axis cylinder becomes sclerogenic, which would place the fibrosis secondary to the degenerative changes. On the other hand, there are areas in several of the sections in which there is a strong suggestion that the fibrous tissue may be encroaching upon the nerve fibers and choking them out. Which is the primary process seems very difficult to determine definitely. At any rate, in this series of cases, the association of macrodactyly with pathological changes in the peripheral nerves has been constant. The pathologists with whom the slides have been discussed have all agreed that the changes are definitely pathological, but they have not all agreed as to their classification.

Localized hypertrophy of various portions of the body have rather frequently been found in cases showing clinical stigmata of von Recklinghausen's neurofibromatosis. Brooks and Lehman reported such a series of leg hypertrophies. Campbell reported a case of congenital hypertrophy of one leg, in which biopsy confirmed the clinical evidence of neurofibromatosis. The author has reported three similar cases of overgrowth of one leg, which showed not only clinical evidence of neurofibromatosis, but definite confirmation by biopsy. Winestine reported an autopsy in which localized overgrowth of a segment of the intestine was found associated with neurofibroma of the nerve supplying that segment. With this evidence of association of localized overgrowth and nerve pathology, it seemed logical to examine the nerves in cases of macrodactyly. However, in only one other reported case has any mention of investigation of the peripheral nerves been found. Baraldi and Ruiz reported a case of marked overgrowth of a thumb and forefinger, in which there was found a tumor of the median nerve diagnosed as a neurinoma. It may be noted that many pathologists do not make a sharp distinction between neurinoma and neurofibroma, so the difference in diagnosis may be largely a matter of terminology. Certainly the

photomicrograph of the case of Baraldi and Ruiz very closely resembled the findings in the author's Case 1.

Brooks and Lehman in discussing their cases of localized overgrowth expressed the belief, "there is no other cause for rapid overgrowth of an extremity than neurofibromatosis", or, to put it in other words, they consider localized giantism as one of the signs of neurofibromatosis, though not an essential one,—that is, neurofibromatosis may be present without localized overgrowth, but localized overgrowth presupposes the presence of neurofibromatosis. The classical signs of the condition as given in the textbooks are:

1. Pigmented areas in the skin (*café au lait* spots).
2. Cutaneous tumors, pedunculated or sessile.
3. Plexiform tumors of the nerve trunks.

It should be noted that the cutaneous tumors occur rarely in children, even when typical pigmentary changes are present, but they frequently develop in these cases during late adolescence.

In this series of macrodactyly, of the four children, two showed definite pigmentary changes, and a third was indefinite but suggestive in this respect. None of them had cutaneous tumors, and in none of them were there palpable tumors of the nerve trunks.

The author has already mentioned that, while the histology of the nerves in the children was definitely abnormal, it was difficult to classify the condition as neurofibromatosis. If one accepts Dorland's brief definition of neurofibroma as "a connective-tissue tumor of the nerve fiber fascicle, formed by proliferation of the perineurium and endoneurium", then the condition here described might be so classified. It must be considered that the nerve tissue available for examination in these cases was only from the smaller terminal cutaneous branches. (Incidentally, they were very difficult to find in the mass of fatty subcutaneous tissue.) No information is available as to the condition of the larger nerve trunks. To offset this, the opportunity has been taken in other cases of proved neurofibromatosis, to examine the finer terminal branches of the nerves, and a pathological picture has been found strikingly like that in the sections from the cases of macrodactyly. There is a possibility that the larger portions of the nerve trunks might show more classical types of neurofibroma. There is still another possibility to be considered.

The one case in which a typical neurofibroma was found was a young adult. The others, in which only an increase in endoneurial fibrous tissue (referred to as fibrotic degeneration) was found, have been in young children. This raises the question as to whether a neurofibroma in a child is the same as in an adult. The process may be progressive, and the findings in the author's sections might be different later in life. This is, of course, theoretical, and will need further observation before the question can be answered. Some slight evidence on the point is the clinical fact, already mentioned, that skin tumors are rare in children, but that they frequently develop in cases which show only *café au lait* pigmentation.

tion in early childhood. This certainly indicates some progression and change in the condition. The progression in the clinical features of neurofibromatosis has been observed and commented on many times. It has led to the generally accepted theory that neurofibromatosis is a congenital condition, and that it passes through various phases of development. This theory has been the outgrowth of clinical rather than histological observation, but if the author's findings in the nerves represent an early stage of neurofibromatosis (as he feels they do) they tend to confirm the developmental theory.

Another point to be considered is whether the nerve pathology is to be regarded as the cause of the malformation of the member. One objection to so believing is that, since we are dealing with a malformation in which all the structures (skin, bones, and subcutaneous tissues) are abnormal, it would be expected that the nerves would also be abnormal. Brooks and Lehman, who have been quoted, did consider that the nerve condition was the cause of the overgrowth and that it acted by direct stimulation. However, another mechanism must be considered. The growth of members of the body is the result of two factors, — the growth impulse and some factor or group of forces limiting and directing the growth into the normal pattern. If this latter inhibitory factor fails to act, the result would be abnormal growth. The author feels that the nervous system may be the regulatory mechanism. However, this cannot be definitely proved. It does, however, suggest an interesting, but difficult research problem.

SUMMARY AND CONCLUSIONS

Five cases of macrodactyly are presented, in all of which pathological changes were found in the peripheral nerves. In one (a young adult), the changes were definitely classed as due to a neurofibroma. In the four others (all young children), the changes were an increase in endoneurial fibrous tissue, with evidence of degenerative changes in nerve fibers. Three of the four children showed at least some of the clinical stigmata of neurofibromatosis. It would seem then that the changes shown in these nerves may represent an early stage in the development of a neurofibroma. Case 3 is particularly suggestive in this regard.

The fact that local hypertrophy is so constantly associated with peripheral nerve pathology, would seem to indicate that there is a relationship between them. It is believed that the nervous system exerts some controlling action on the process of growth, and that the impaired nerves fail in this function, resulting in uncontrolled or uninhibited growth. Whether there are changes in the central nervous system which result in the change in the peripheral nerves is not known.

These observations seem to favor the neurogenic theory as the origin of at least certain types of congenital deformities. The author feels that the investigation of pathology in the peripheral nerves has been somewhat overlooked, and that more careful work along this line might be of great interest.

The author feels indebted to Loyal Davis, M.D., for interest in this investigation. On the pathological changes he has received help and valuable suggestions from Arthur Weil, M.D., Francis D. Gunn, M.D., and Hamilton R. Fishback, M.D., of Northwestern University Medical School. George J. Rukstinat, M.D., of Rush Medical College, has also been very helpful in carefully studying the pathological slides.

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A MODIFIED OPERATION FOR OPPONENS PARALYSIS *

BY T. CAMPBELL THOMPSON, M.D., NEW YORK, N. Y.

From the Hospital for Special Surgery, New York

The power of opposing the thumb to the fingers is one important way in which man differs from the rest of the animal kingdom, and is the fundamental reason for his manual dexterity. Loss of the power of opposition is a much greater disability than those of us who possess it can realize. Restoration of this power has not interested orthopaedic surgeons as much as it really should, although some of them have realized the importance of this function and several ingenious operations have been devised to restore it. No attempt will be made to enumerate or describe all of the operations that have been designed, but the author would like to explain the Royle operation together with a modification which has been developed in the past few years at the Hospital for Special Surgery, formerly known as the Hospital for Ruptured and Crippled.

The operation designed by Royle is described as follows:

"Step 1.—The skin is opened through the transverse fold at the base of the ring finger. By retracting the skin distally, one can reach the insertion of the bifurcated tendon of the flexor sublimis with a tenotome, with which it is then cut through on each side.

"Step 2.—The sheath of the flexor pollicis longus is opened through an incision at the deep fold proximal to the metacarpophalangeal joint of the thumb.

"Step 3.—An incision is made in one of the transverse folds of the palmar aspect of the wrist. The cut tendon of the ring finger is then drawn out through this incision. It is *passed up the sheath of the long flexor of the thumb* † and brought out at the incision at the metacarpophalangeal joint of the thumb.

"Step 4.—The attachment of the short flexor [of the thumb] and of the opponens pollicis is next exposed by dissecting up the skin distally. One part of the bifurcated tendon of the superficial flexor of the ring finger is stitched to the attachment of the short flexor with the first phalanx in flexion. The other part is stitched to the outer edge of the opponens pollicis with the thumb in opposition."

The apparent simplicity of this procedure has probably appealed to many orthopaedic surgeons. Several such operations were done at this Hospital shortly after this article appeared. Experience with the technique of the procedure showed it to be not nearly so simple as one would expect, and the results were not so satisfactory as one would wish. In Royle's description of the procedure, he pulls the flexor sublimis tendon of

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† The italics are the author's.

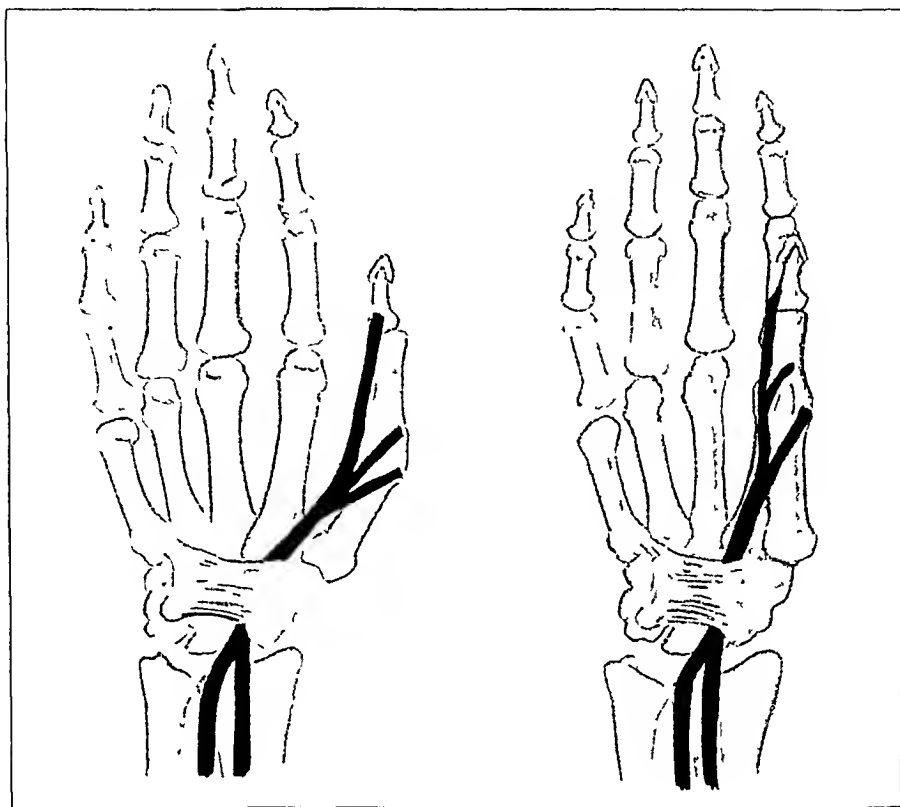


FIG. 1

Diagram showing the mechanics of the Royle or Steindler operation.

the fourth finger *distally* through the sheath of the flexor pollicis longus tendon. It fits into its sheath quite tightly and there really is no room for an additional tendon. Considerable difficulty is encountered in sliding this extra tendon down through the sheath, and this may be one reason why the action of the transplanted tendon is not too satisfactory later. The tendon emerges from the sheath of the flexor pollicis longus somewhere along the shaft of the first metacarpal bone. The same is true in Steindler's operation where the flexor pollicis longus tendon itself is split, and the radial half is brought out of the sheath and around the first metacarpal. The mechanics of these two procedures are essentially the same, in that the pulley from which the rotation takes place is *really the exit* of the tendon from the sheath of the flexor pollicis longus. The action of the tendon, down to the point where it emerges from the sheath, is really exactly the same as that of the flexor pollicis longus. The point of exit of the tendon from the sheath is not far enough away from the axis of the shaft of the first metacarpal bone, nor from the point of insertion of the tendon into the bone, to insure a good range of adduction and rotation. In order to produce efficient rotation of a bone, the muscle or tendon should run as nearly as possible at a right angle to the shaft of bone, rather than in a long spiral around it. It is a well-recognized mechanical prin-

phalangeal joint, rather than rotation. However, in his illustration he shows both parts of the sublimis tendon sutured well over on the dorsal surface of the thumb, so that they would really act as a rotator and pull the thumb into opposition.

In the anatomy review courses that have been given by, and for, the house staff of the Hospital for Special Surgery in the last two years, the opportunity has been taken to test out some of the procedures for restoring opponens action of the thumb. It has been found that a modification of the Royle operation will produce much more efficient opposition than any other procedure. On the cadaver, it was found that the flexor sublimis tendon of the fourth finger could be identified quite readily through a short longitudinal incision at the base of the palm of the hand just to the radial side of the hypothenar eminence. This incision was just to the ulnar side of the median nerve. When the tendon had been severed at the base of the fourth finger, as described by Royle, it was drawn out through this incision in the palm *below*, instead of above, the transverse carpal ligament. From this point it was drawn subcutaneously across the center of the thenar eminence to the distal end of the first metacarpal bone, and the base of the proximal phalanx of the thumb. A pulley at some distance from the base of the thumb was thus formed by the lower border of the transverse carpal ligament. The action in adduction, and especially in rotation of the thumb, was much more efficient than when the tendon was brought out above the wrist and threaded distally through the sheath of the flexor pollicis longus. A slight, but important, change was also made in the method of inserting the transplanted flexor sublimis tendon. A dorsal incision was made along the line of the extensor pollicis longus tendon, instead of the one described by Royle. A hole was drilled through the distal end of the first metacarpal, so that the tendon would enter this bone just to the radial side of the extensor pollicis longus. The external rotating action of these two muscles, which are usually present, is difficult to overcome. One half of the transplanted muscle was threaded through this hole and the metacarpal bone pulled over into as much opposition as possible. The other half of the tendon was then brought around the dorsal surface of the thumb, superficial to the extensor pollicis brevis and extensor pollicis longus tendons, and drawn through a small tunnel in the fascia and periosteum at the base of the proximal phalanx. The two ends of the transplanted sublimis tendon were then sutured together. In this way full internal rotation of the metacarpal bone was secured, and a little additional rotation was obtained at the metacarpophalangeal joint without causing flexion at this joint. Since finding that this worked to so much better mechanical advantage on the cadaver than the procedure described by Royle, a number of patients have been operated upon with this technique. The results have been most encouraging.

Mayer, who has been interested in restoration of opposition of the thumb, has emphasized the point that in patients who have had paralysis

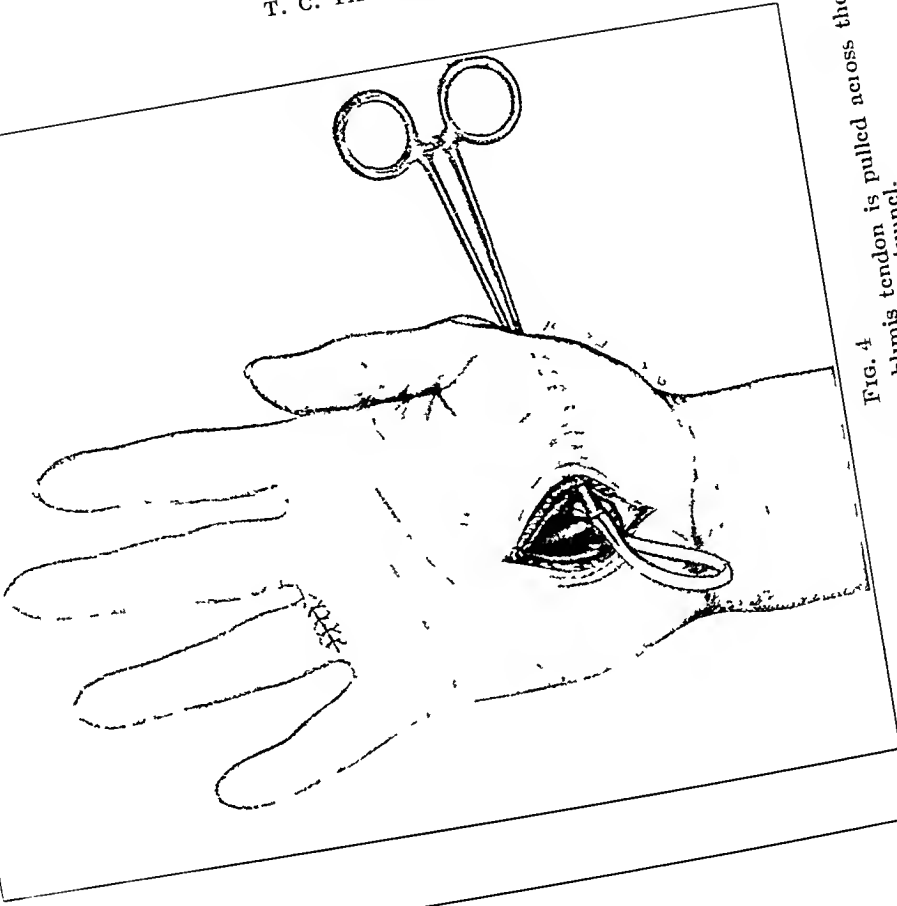


FIG. 4

(Steps 3 and 5) The flexor sublimis tendon is pulled across the thenar eminence through the subcutaneous tunnel.

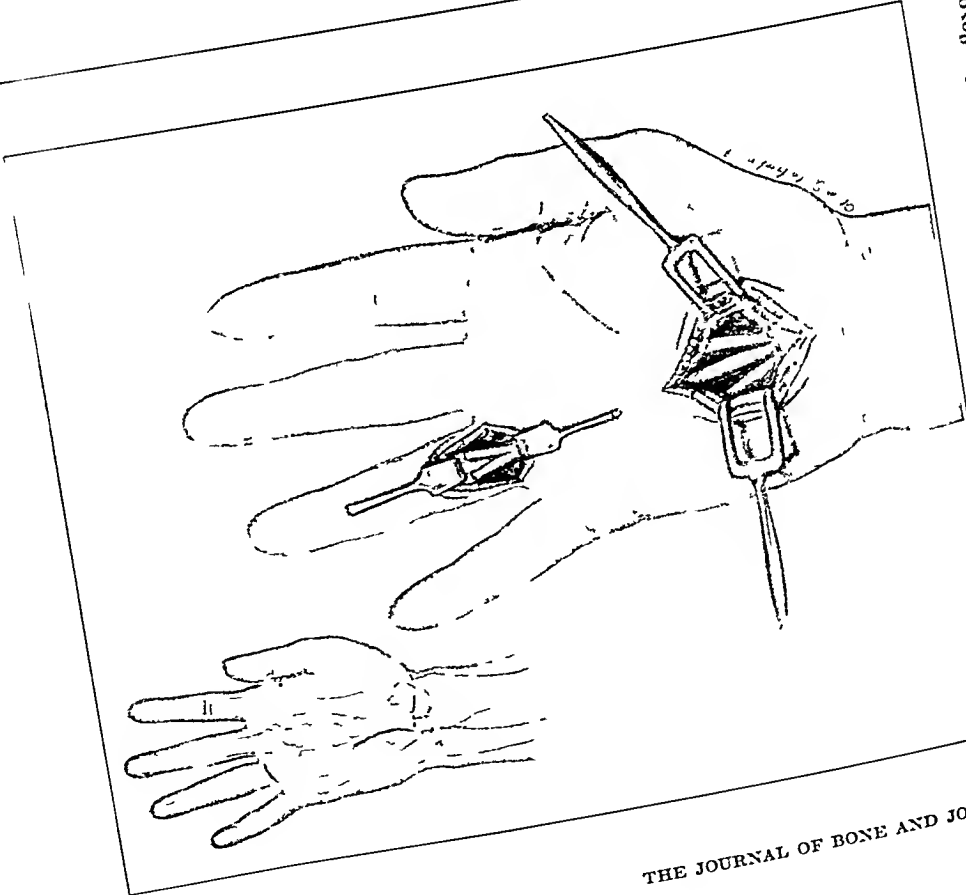


FIG. 3

(Steps 1 and 2) Incisions in the palm and exposure of the flexor sublimis to the fourth finger.

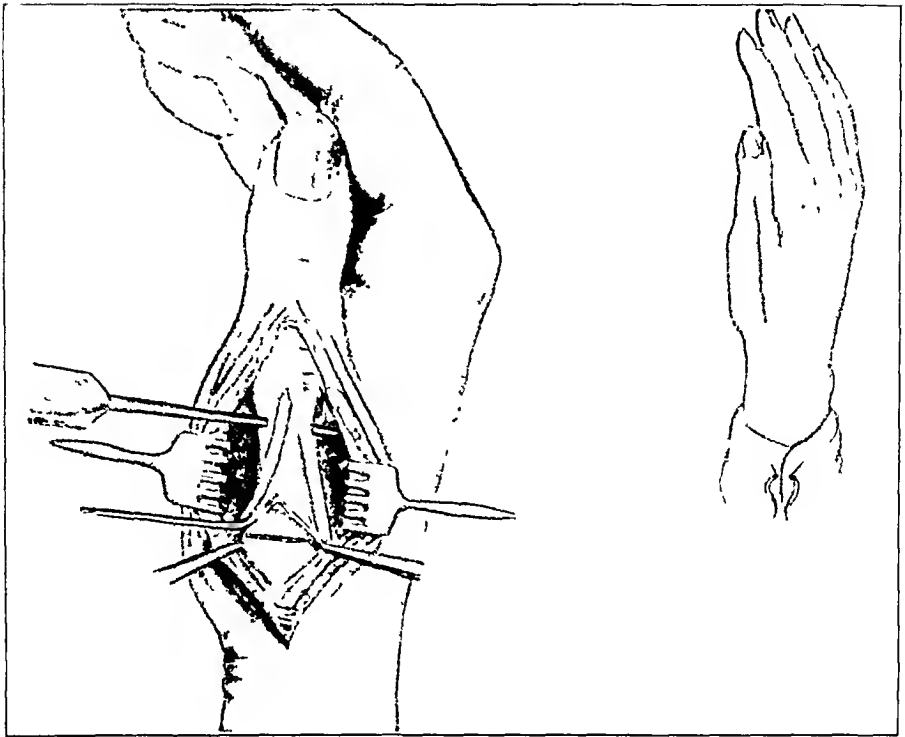


FIG. 5

(Steps 4, 6, and 7) An osteotomy at the base of the first metacarpal is done if the deformity is fixed.

for some time a fixed deformity develops, which cannot be easily overcome. He has advised capsulotomy of the joint at the proximal end of the first metacarpal to relieve this contracture. Even after a thorough capsulotomy, rotation of the thumb may still be quite difficult. In these cases where the deformity is so fixed that passive opposition cannot be obtained, the author thinks that the easiest, surest, and most satisfactory way of putting the thumb in a position of opposition is to do an osteotomy near the base of the first metacarpal and rotate the thumb into the desired position. One cannot expect a transplanted muscle to act strongly enough to correct a fixed deformity. The deformity must be corrected separately, and the tendon transplant merely serves to give active power in the new position. It might be preferable to do the osteotomy and the tendon transplant at different times. Certainly some of the author's results would have been better if the fixed deformity had been adequately corrected.

The steps in the modified operation are as follows:

Step 1. An incision is made in the palm three centimeters in length at the radial side of the hypothenar eminence, and the flexor tendons are exposed at the lower border of the transverse carpal ligament. The flexor sublimis tendon to the fourth finger is identified, and a blunt hook is placed around it (See Figure 3).

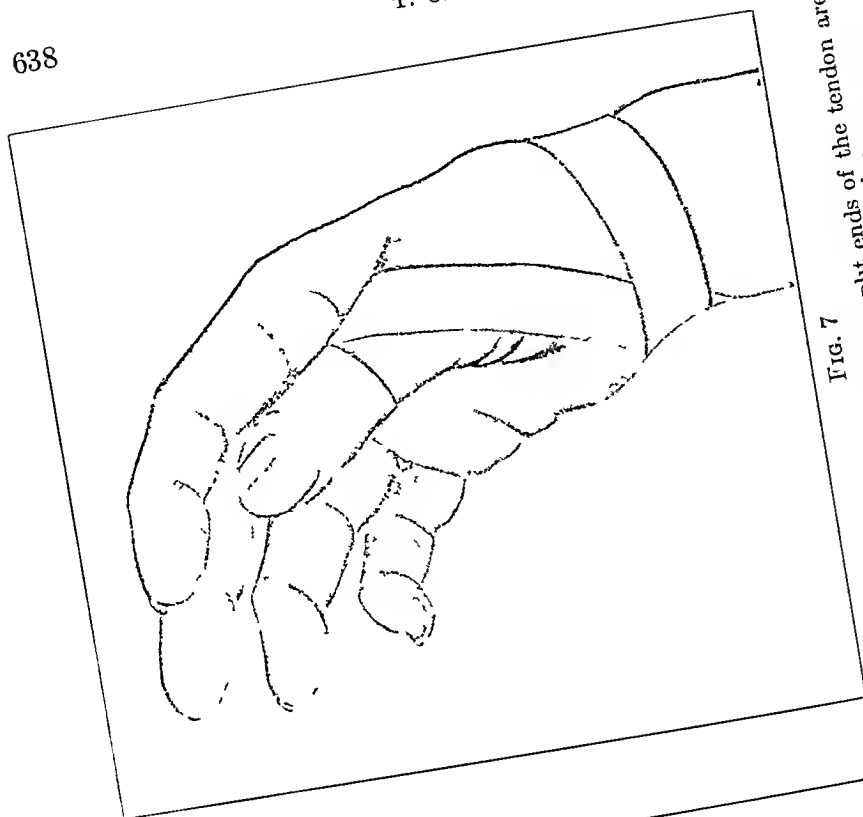


FIG. 7
Fig. 6. (Steps 7, 8, and 9) The split ends of the tendon are fastened firmly, holding the thumb in opposition.

Fig. 7. (Step 10) Spiral adhesive strapping holds the thumb in a position of opposition.

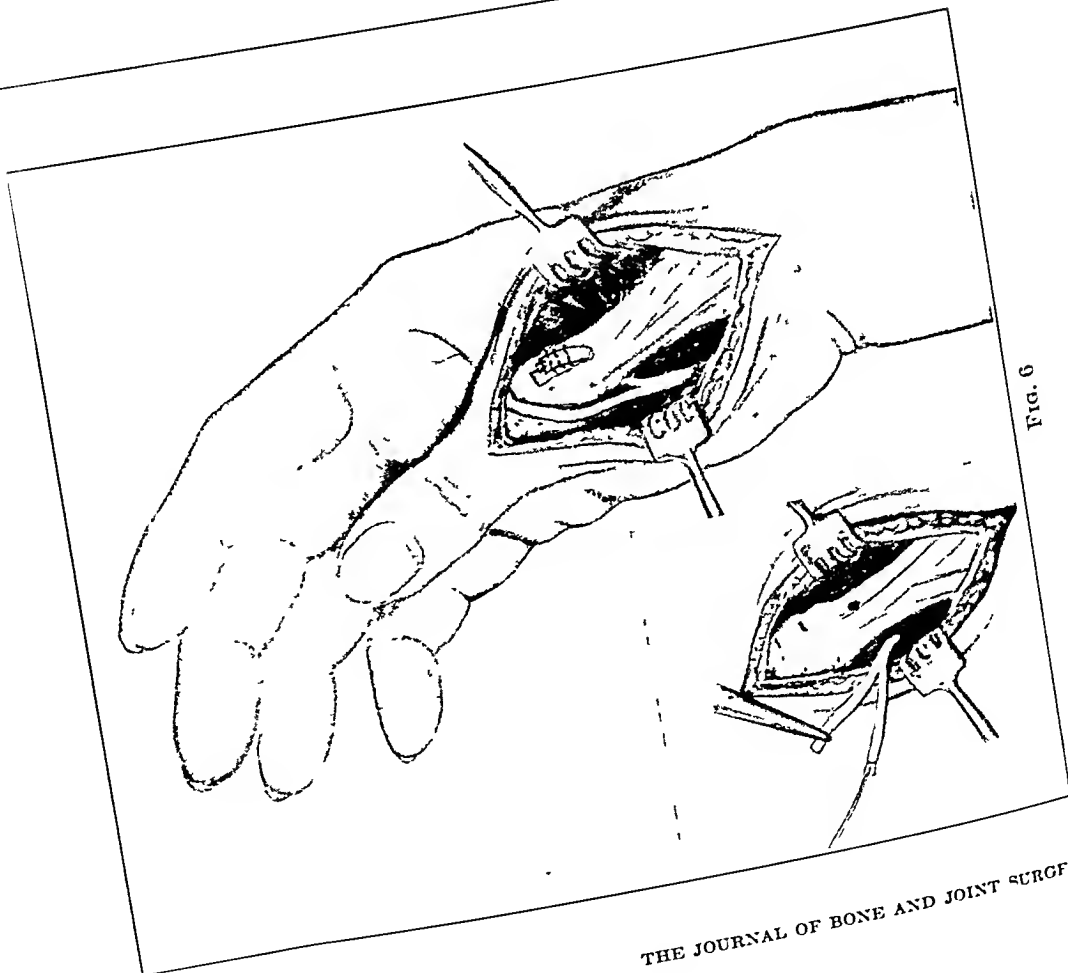


FIG. 6

Step 2. The flexor sublimis tendon is exposed through a transverse incision at the base of the fourth finger, and the two heads are sectioned as described by Royle (See Figure 3).

Step 3. The tendon is drawn out through the incision in the palm, and the incision at the base of the fourth finger is closed (See Figure 4).

Step 4. The hand is turned over and an incision is made on the dorsal surface of the thumb over the extensor pollicis longus tendon (See Figure 5).

Step 5. A subcutaneous tunnel is made across the thenar eminence, and the tendon of the flexor sublimis to the fourth finger is pulled through this tunnel (See Figure 4). The incision in the palm is closed.

Step 6. A hole is drilled through the first metacarpal near the distal end of the bone. This enters on the radial side of the extensor tendons and comes out on the ulnar side of them (See Figure 5).

Step 7. One-half of the transplanted tendon is drawn through this hole. If the first metacarpal is not pulled into sufficient opposition by this tendon, the incision is lengthened toward the wrist, and a transverse osteotomy is made near the base of the first metacarpal, and the bone is rotated (See Figure 5).

Step 8. The other half of the transplanted tendon is brought over the extensor muscles of the thumb, and drawn through a small fascial and periosteal tunnel, at the base of the proximal phalanx (See Figure 6).

Step 9. The two ends of the tendons are pulled up quite tightly to hold the thumb in full opposition and are sutured to each other (See Figure 6). The skin incision is closed.

Step 10. The thumb is held with a spiral adhesive strapping for four to six weeks. Active use is encouraged at once (See Figure 7).

DISCUSSION

In the past four years there have been fourteen cases and fifteen operations for opponens paralysis. One was a Bunnell type of free-tendon transplant, together with a capsulotomy at the metacarpophalangeal joint as advocated by Mayer. This worked very well for about a year, but gradually the fixed deformity of the thumb recurred, and the power of opposition was lost.

Two Steindler operations were performed. The result of one of these was quite good, and the patient now plays the piano. She does, however, prefer to write holding the pencil between the second and third fingers. The other Steindler operation was a complete failure, even after two attempts at repair, and the patient has a flexion contracture of the interphalangeal joint.

Two regular Royle operations were done; one is quite satisfactory and the other is poor, possibly because there was too much fixed deformity of the thumb.

Nine patients have been operated upon, one on both hands, by the procedure described. One of these had an osteotomy at the base of the

first metacarpal. Of the ten operations, the results of five are rated excellent; three, good; one, fair; and one, poor. In the case rated "poor", the patient fell on the hand about a month after the operation, and since then has lost practically all of the power of opposition which she had had up to that time. In the case rated "fair", the hand was badly paralyzed, and the tendons of the fourth finger were quite adherent. In this case there must have been considerable trauma to the median nerve, as there was a loss of sensation for several months afterward along the median distribution. The position of the thumb is better, and the function of the hand is improved. The results in all of the other cases exceeded expectations.

CONCLUSIONS

The procedure described is a fairly simple, yet efficient, way of restoring opponens power. In the author's experience, it gives better results than the other more complicated methods which have been tried.

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SULFONAMIDES IN TRAUMATIC AND INFECTED WOUNDS

A REPORT OF THEIR USE IN FRESH COMPOUND FRACTURES, OLD COMPOUND FRACTURES WITH INFECTION, AND CHRONIC OSTEOMYELITIS.* †

BY LENOX D. BAKER, M.D., DURHAM, NORTH CAROLINA

From the Orthopaedic Division of the Department of Surgery, Duke University School of Medicine, Durham

Frequently new therapies, or adjuncts to old therapies, are introduced in such glamorous terms that, in their acceptance, the underlying principles of surgical treatment are overlooked, resulting in a neglect of the old tried methods and an abuse of the new; the sulfonamides have been no exception to this rule. There can be no question as to their efficacy in certain infections, but, from the following analysis of 121 cases of chronic bone infection and 270 fresh compound fractures, it is apparent that the local use of these drugs is of help in combatting infection only when the fundamental rules of wound hygiene have been followed. Of the 270 fracture cases, 257 were treated within six hours of the injury, nine in six to twelve hours, and four in twelve to twenty-four hours. It seems that one of the dangers in the use of the drugs is the false security one is likely to acquire, at the sacrifice of established surgical principles.

Before the statistics are analyzed, certain facts concerning the actions and relative efficiency of the various sulfonamide derivatives may be an aid in interpreting the findings. It has been shown that small tissue fragments or products of protein hydrolysis in a tissue culture markedly reduce the antibacterial effect of sulfanilamide, as the bacteriostatic action of sulfanilamide is inhibited by the presence of peptone.

Hawking, from his experimental work, concluded that, in dead tissue, sulfanilamide has a higher local concentration and greater powers of penetration and diffusibility, but disappears more rapidly from the wound and has much lower bacteriostatic activity than sulfathiazole, and that tissue with an intact circulation can be reached more quickly and effectively by oral administration.

The work of Dickson, Diveley, and Kiene on the use of sulfathiazole in chronic osteomyelitis, and the laboratory studies of Poston and others, have shown that the thiazole derivative has the highest bacteriostatic effect on the staphylococcus organism.

Sulfathiazole, when used in small amounts and when well distributed throughout the wound, does not appear to interfere with wound healing. When used in too large amounts and when not well distributed, sulfathiazole is more likely to form insoluble concretions which

* Presented at the Annual Meeting of The American Academy of Orthopaedic Surgeons, Atlantic City, New Jersey, January 14, 1942.

† Case reports furnished by members of The American Academy of Orthopaedic Surgeons in reply to a questionnaire.

act as foreign bodies than are sulfanilamide crystals which are more absorbable.

From the general tone of the reports and, in some instances, from definite statements, the sulfonamides apparently do not interfere appreciably with callus formation or bony union, but that point is beyond the scope of this paper, and can be better studied in experiments such as those already so ably carried out by Key and his associates.

This report deals with the use of these drugs under three headings:

1. Fresh compound fractures.
2. Old infected compound fractures.
3. Chronic osteomyelitis.

Originally it was planned to include acute osteomyelitis, but, because of the complexity of the disease and the diversity of the methods of treatment, it was felt that the discussion of the use of the drugs in acute osteomyelitis should be made in a separate report. The use of these drugs in clean operative wounds is not considered, nor is the incidence of gas infection with its various therapies.

FRESH COMPOUND FRACTURES

This series of cases consisted of 270 compound fractures in which one, or more, of the sulfonamides was used locally. In a few of the cases, sulfanilamide and sulfathiazole were combined in the local therapy; in the majority of the group sulfanilamide was used locally in combination with the oral use of sulfathiazole. The relative value of the two drugs is difficult to determine on the basis of these cases; there are too few of them, and the circumstances of their treatment are too variable for a definite conclusion on the marked superiority of any one of the sulfonamides over the others when used locally in traumatic wounds.

Only those cases which were reported individually with definite statements regarding treatment and results are included in the report. Of the 242 fresh compound fractures treated by surgery and the local implantation of sulfanilamide, 192 cases healed without infection; fifty showed some degree of postoperative infection. Sulfathiazole was used in twenty-eight cases. Only three of these showed any postoperative infection; and of these three, one patient was operated upon twelve hours after a previous closure, and, in another, inadequate débridement was admitted by the reporting surgeon. Of 252 cases with primary closure, forty-seven had some degree of postoperative infection, and 205 healed *per primam*. In fourteen cases the wound was packed with vaseline gauze; eleven healed cleanly and three became infected. In four cases postoperative drains were used for twenty-four to forty-eight hours; infection developed in three. Internal fixation was used in 126 cases, of which ninety healed cleanly, and thirty-six became infected; however, seventeen of the thirty-six were reported as healing satisfactorily. Comments on the use of internal fixation in these potentially infected wounds pointed to the advantages of rigid fixation in good alignment, comfort to the patient, and

TABLE I
FRESH COMPOUND FRACTURES

Treatment	Total	Healed	Infected
Open reduction plus chemotherapy	270*	217	53
Sulfanilamide	242	192	50
Sulfathiazole	28	25	3†
Primary closure	252	205	47
Open method	14	11	3
Drained	4	1	3
Internal fixation	126	90	36

* 257 patients were operated upon within six hours; nine, in six to twelve hours; and four, in twelve to twenty-four hours.

† One patient was operated upon twelve hours after previous closure, and one had an inadequate débridement.

ease of applying casts or other types of outside support. Disadvantages also were reported, — such as dead spaces back of ill-fitted plates, separation of the fragments being maintained following absorption at the fracture site, and, in the open or infected cases, failure of the granulation and callus to cover the plates.

The surgical and the supportive treatments in these compound wounds have not been standardized; therefore the statistics do not represent what can be expected when the drugs are used in combination with thorough surgery and ideal supportive care; on the other hand, the favorable aspects of the statistics do not represent what can be expected of the drugs alone.

The results, from the viewpoint of the time elapsed between the injury and the débridement and implantation of the sulfonamide, showed no variation in the percentage of primary healing between the group treated within the first six hours and the group treated within the second six hours. There were only four cases reported in which surgery had been performed after a lapse of twelve hours; all four healed *per primam*. However, these are too few cases to be of any value in judging what can be expected from the therapy in compound fractures treated twelve hours or more following injury.

In correlating the results, it appears that the incidence of infection does not coincide in its entirety with the degree of injury; and that apparently, in many of the cases, the presence of infection is due to the lack of proper débridement and the lack of restoration of normal anatomical relationship, rather than to the type of injury or to the drug used. Previous reports on the incidence of infection in compound wounds have dealt with severe infection, and the percentage of such infection in 852 cases accumulated from the literature ranged from 6.3 to 17.3 per cent. In the 270 cases of fresh compound fractures herein reported, severe infection developed in twenty-seven cases, an average of 10 per cent. The incidence of all infections was 19.6 per cent. This figure is essentially the

same as that reported by Campbell and Smith. In comparing the end results in this series of cases with those reported before the use of this form of chemotherapy, one is impressed by the fact that no operation is more difficult than a débridement and no condition demands keener surgical judgment.

In a compound fracture there are four challenging factors: foreign material, devitalized tissue, the disturbance of the anatomical relationship of the parts, and infection. When properly used, the sulfonamides may help in ridding the wound of only one of these, infection. If the first three factors are not remedied by the surgeon, catastrophe, as seen in some of the cases reported, is frequently the result. The importance of meticulous débridement and thorough wound hygiene has been emphasized in

TABLE II
OLD COMPOUND FRACTURES WITH INFECTION

Treatment	Total	Healed	Infected
Open reduction plus chemotherapy	47	30	17
Sulfanilamide	14	7	7
Primary closure	7	5	2
Open method	7	2	5
Sulfathiazole	33	23	10
Primary closure	20	17	3*
Open method	13	6	7

* All had drains for twenty-four to forty-eight hours.

the reports of the more conservative observers, and many of the communications have contained statements with regard to the necessity of restoration of anatomical relationship and adequate postoperative fixation. It appears that, after these factors have been properly attended to in a painstaking and thorough manner, the presence of a small amount of the sulfonamides is of assistance in abating infection.

The fact that the statistics favor primary closure must be discounted to some extent, as closure of the wound was contra-indicated in many instances because of the definite likelihood of infection, and in some cases because of the avulsion of large areas of soft parts. Whether a wound is closed, or packed and allowed to heal in by granulation tissue and epithelization, is of little ultimate consequence, except from the economic aspect which markedly favors the closed method of therapy.

OLD COMPOUND FRACTURES WITH INFECTION

Reports were received on forty-seven cases of old compound fractures with active infection, which were treated by open reduction and the local implantation of a sulfonamide. In fourteen cases sulfanilamide was used; in seven there was clean healing, and in seven postoperative infection developed. Of the seven healed cases, five were treated by primary

closure and two by the open method. Of the seven infected cases, two were closed and five were packed. Sulfathiazole was used in thirty-three infected old compound fractures. Twenty-three healed, and ten showed some degree of postoperative infection. Of the twenty-three healed cases, seventeen were treated by primary closure and six by the open method. Of the ten infected cases, three were closed and seven were packed.

CHRONIC OSTEOMYELITIS

In the treatment of seventy-four cases of chronic osteomyelitis, in which saucerization, irrigation, implantation of a sulfonamide, and complete closure were carried out, the results are most satisfactory. Fifty-four healed cleanly, and twenty showed some degree of postoperative in-

TABLE III
CHRONIC OSTEOMYELITIS

Treatment	Total	Healed	Infected
Surgery plus chemotherapy.....	74	54	20
Sulfanilamide.....	11	7	4
Primary closure.....	4	4	0
Open method.....	7	3	4
Sulfathiazole.....	63	47	16*†
Primary closure.....	41	36	5
Open method.....	22	11	11

* Seven later healed. † Three had severe flareups.

fection. However, seven of the cases which were infected healed later, leaving a residual infection in only 16 per cent. of those treated. Sulfanilamide was used in eleven cases, of which seven healed. Of the seven, four were closed following surgery and three were packed with vaseline. The four which showed postoperative infection were all treated by the open method. Sulfathiazole was used locally in sixty-three such cases. Forty-seven healed cleanly, and sixteen showed some degree of postoperative infection. Of the forty-seven cases treated with sulfathiazole which healed, thirty-six were treated by the closed method and eleven by the open. In the sixteen infected cases, five were closed and eleven packed with vaseline gauze. The relative lack of improvement from the addition of the sulfonamides to the open method of treating chronic osteomyelitis, brings up the question as to what result could be obtained in this condition from adequate surgery and complete closure without the drugs.

These drugs challenge us as surgeons, and already because of an increased interest, or because of increased confidence in obtaining primary healing, we are being more thorough in our débridements, more meticulous in our attempts at closure, and as a result more satisfied with our end results. It may well be that these drugs, or one of their derivatives, will

prove of inestimable value as surgical adjuncts; certainly they have brought to light again the necessity for thorough surgery.

Sincere appreciation is expressed to those who have contributed case reports for this study; without their assistance the survey could not have been made.

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ACUTE HEMATOGENOUS OSTEOMYELITIS IN THE ADULT

BY JACK E. MAXFIELD, M.D., AND C. LESLIE MITCHELL, M.D.,
DETROIT, MICHIGAN

From the Division of Orthopaedic Surgery, Henry Ford Hospital, Detroit

Acute primary or hematogenous osteomyelitis in the adult is a relatively uncommon disease which should be considered a separate clinical entity. There are only two papers in the literature which deal with this subject in any detail. Zadek and Leclerc have both given case reports and discussions. Other than these, one can find only isolated case reports and comments given incidentally with large series of childhood cases. Of particular interest in this connection is Butler's report of 500 cases of which forty-five were in adults.

The authors have observed five cases of the acute disease in adults in the past three years, and feel that they present some features which are worthy of emphasis.

In the case reports to follow, it will be noted that the symptomatology of the adult disease is strikingly different from that of the childhood type. The onset is a matter of weeks or even months, the pain is vague and may shift location from day to day. The pathology is most apt to appear near the center of the diaphysis. Although the patient may have considerable fever, there is usually very little toxicity.

CASE REPORTS

CASE 1. P. V., a white male, twenty-four years old, was first seen on May 3, 1939, complaining of throbbing pain in the left knee of one week's duration. There were no local findings and roentgenograms of the knee and hip were negative. By May 23 there was tenderness, local heat, and swelling in the mid-thigh, with leukocytosis of 15,400, and temperature of 103 degrees. Roentgenograms of the femur (Fig. 1-A) showed light periosteal reaction with a suggestion of localized osteoporosis in the medullary cavity. An osteotomy was done, and considerable pus escaped under pressure from the central canal. A culture showed staphylococcus aureus. On the seventh postoperative day, a pathological fracture occurred while the patient was getting on a bed pan (Fig. 1-B). Progress was slow, with repeated acute exacerbations of infection, but union of the fracture was obtained.

CASE 2. J. R., a negro male, twenty-one years old, was first seen on September 10, 1941, complaining of "charley-horse" in the right thigh of three weeks' duration. There was tenderness, induration, and deep-seated swelling over the lower right thigh. Temperature was 103 degrees, and white blood count was 11,000, but the patient did not appear ill. Roentgenograms of the femur showed a minimal amount of light, periosteal reaction (Fig. 2-A). Treatment consisted in chemotherapy, drilling of the femur with the escape of staphylococcus pus, packing of the wound, and application of a long leg cast. On the twenty-third postoperative day the patient put weight on the cast and fractured the femur through the diseased area (Fig. 2-B). There continued to be marked destruction of the femoral shaft, and the development of abundant callus (Fig. 2-C). The wound is still draining and two tiny sequestra have been removed.



FIG. 1-C

Case 1. P., V. Showing extensive involvement a few weeks after diagnosis.

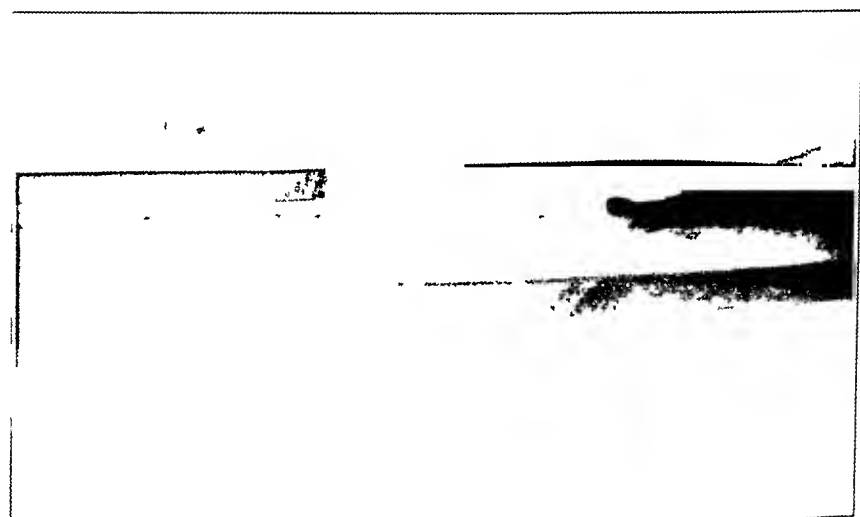


FIG. 1-B

Case 1. P. V. Showing pathological fracture.

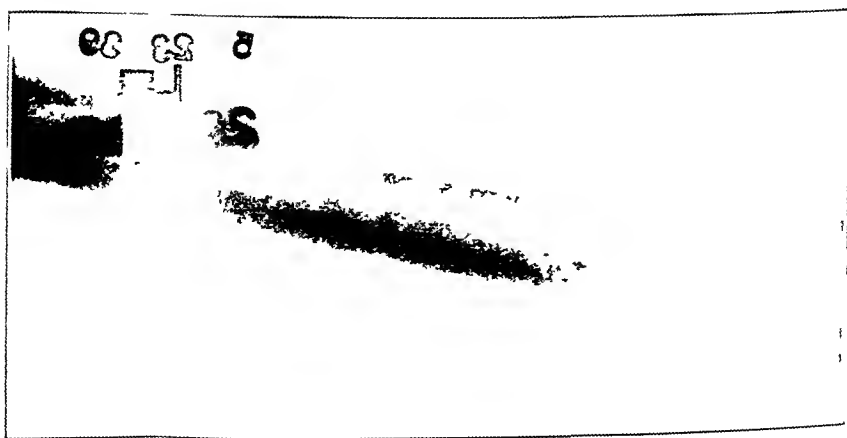


FIG. 1-A

Case 1. P., V. Anteroposterior roentgenogram of the femur showing faint periosteal reaction at the lower right.

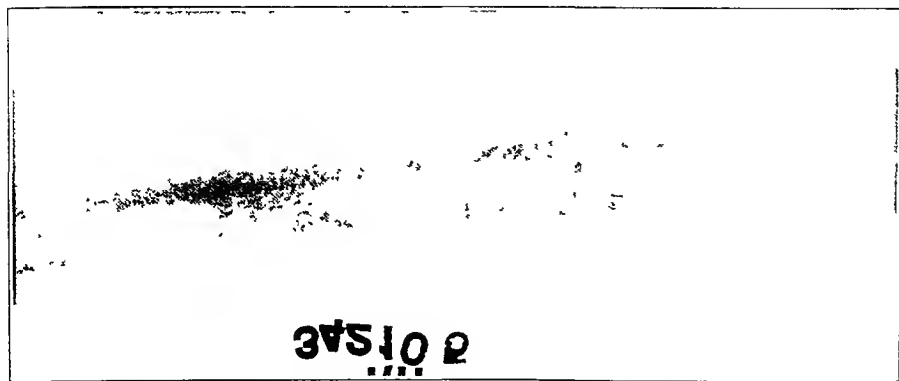


FIG. 2-A

Case 2. J. R. Anteroposterior roentgenogram of the femur upon which diagnosis was made.

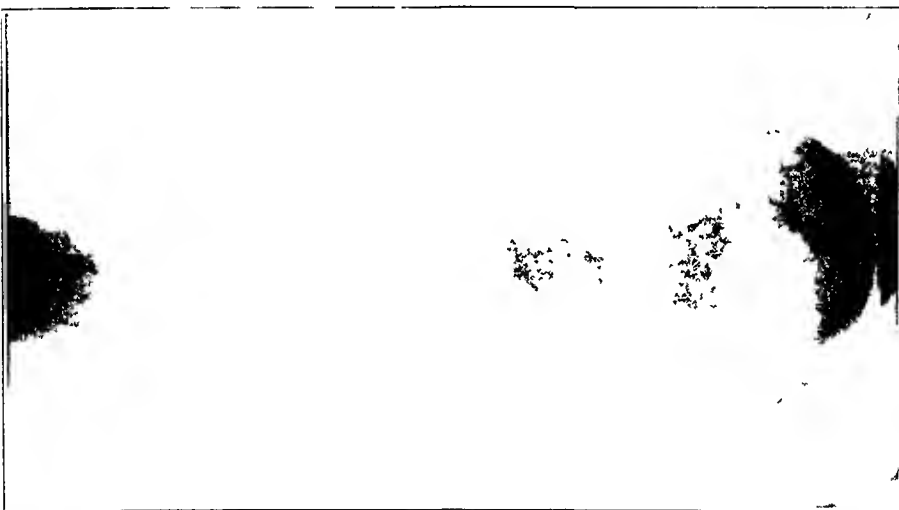


FIG. 2-B

Case 2. J. R. Showing pathological fracture.

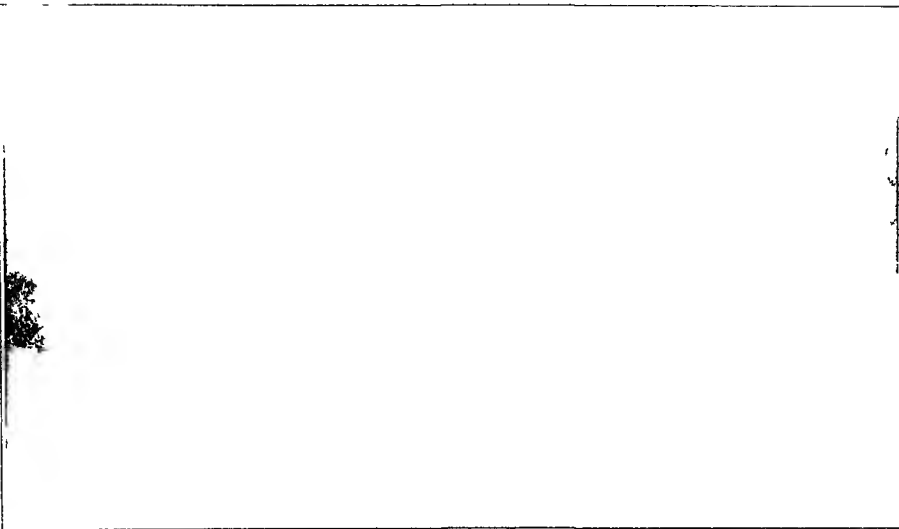


FIG. 2-C

Case 2. J. R. Showing extensive involvement of femoral shaft.

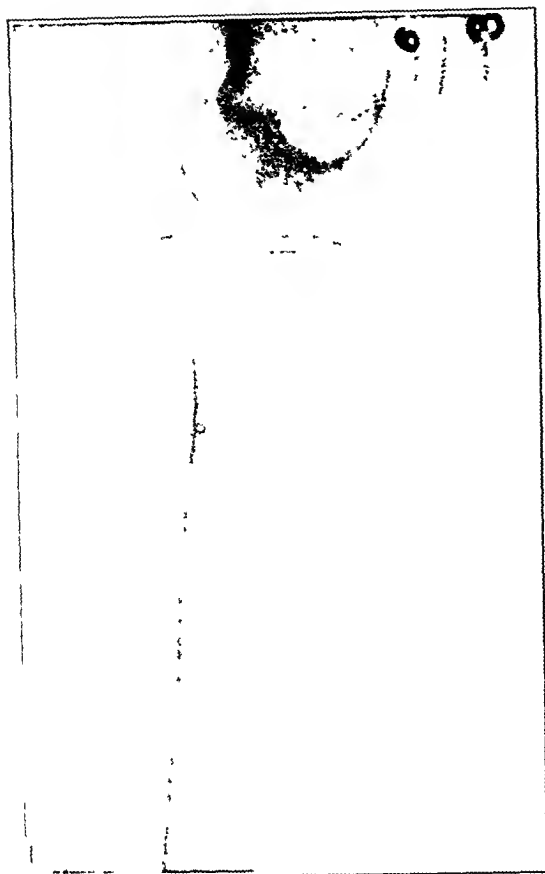


FIG. 3

CASE 3. J. G. Tibia after window had been made. Note the location of the lesion in the diaphysis.

of the humerus. Temperature was 99.6 degrees and white blood count was 16,000. Roentgenograms of the humerus showed widening of the cortex, with expansion of the medullary cavity into cystlike areas, and some new periosteal reaction (Fig. 4). Complete healing occurred two months after saucerization of the bone.

CASE 5. J. A., a white male, twenty-nine years old, was first seen on October 3, 1938, complaining of pain in the right groin of three weeks' duration. Another physician had made a diagnosis of "rupture". There was tenderness in the groin, a leukocytosis of 15,900, and a temperature of 99.4 degrees. Roentgenograms of the hip showed a cystlike area in the upper femoral shaft, with a surrounding, marked periosteal reaction (Figs. 5-A and 5-B). The patient was operated upon elsewhere, and pus was found in the femur.

DISCUSSION

There are two features of special interest in these cases,—namely, the variation in the roentgenographic findings, and the complication of pathological fracture in the two femora. It is to be noted that the first films in each case showed a light periosteal reaction, which is believed to be the chief diagnostic feature. Cases 1, 2, and 3 showed only this reaction. The last two patients, however, had, in addition, one or more central areas of rarefaction which may be interpreted as bone abscesses. (See Figures 4, 5-A, and 5-B.) Whether these

CASE 3. J. G., a white male, sixty-two years old, had had a drainage of an appendiceal abscess on January 27, 1940, and an excision of a carbuncle on his back on May 22, 1940, with a positive blood culture for hemolytic staphylococcus a few days later. On or about June 10, he began to have pain near the upper end of the left tibia, but his temperature and leukocyte count remained normal. The tibia was drilled, and a small amount of pus was found, on June 17. In spite of adequate drainage and extensive chemotherapy, the blood culture remained positive, and the patient expired on July 11, 1940. Figure 3 shows the diaphyseal position of the lesion, after a window had been cut at a second operation.

CASE 4. E. M., a white male, twenty-nine years old, was first seen on November 19, 1940, with a history of intermittent pain in the left arm for four years, with continuous pain, more severe in the past three months. He had already had two neurosurgical operations on the arm at another hospital in an attempt to relieve the pain. There was moderate atrophy of the arm, with tenderness and definite thickening of the mid-portion

central abscesses may have been present long before the occurrence of the acute episode or not, the authors have not been able to determine with certainty, but it seems probable that in Case 4, such a low-grade infection might have accounted for the patient's intermittent pain over a four-year period. In any event, the end picture is not that of a typical Brodie's abscess as described by Brailsford, and Wagner and Hanby. A Brodie's abscess does not show light periosteal reaction; the abscess has bone sclerosis around its margin, and the location is characteristically near the epiphysis rather than in the center of the diaphysis. It is suggested that there may be two distinct pathological types of acute hematogenous osteomyelitis in adults,—Type I, in which there is a primary periosteal involvement with secondary invasion of the medullary shaft, and Type II, in which the infection is primarily a low-grade one in the central area, with secondary spread to the periosteum. In the latter type, the symptoms do not become relatively acute until the time of the periosteal invasion and reaction.

Regarding the complication of pathological fracture in infections of the femoral shaft, numerous isolated examples may be found in the papers of Zadek, Leclerc, Hobart and Miller, Mitchell, and Butler. The occurrence of the fracture is probably directly related to the extensive destruction of the femur by the infection (Figs. 1-C and 2-C), rather than to any particular type of surgery. It should be emphasized that the fracture can occur with a minimal amount of trauma, and that a leg cast will not prevent it. The authors feel very strongly that all cases in adult femora should be treated from the beginning in plaster hip spicas, or their equivalent, in an attempt to prevent this serious complication.



FIG. 4

Case 4. E. M. Anteroposterior roentgenogram of the humerus, showing cystic medullary change and surrounding periosteal reaction.

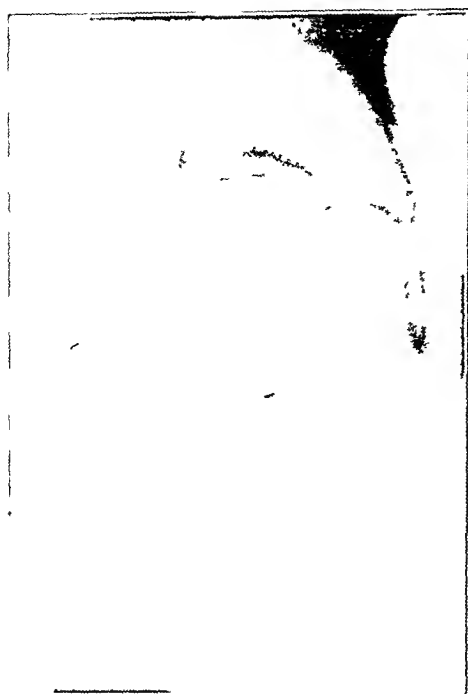


FIG. 5-A

Case 5 J A Anteroposterior roentgenogram of the upper femur, showing cystic change.



FIG. 5-B

Case 5. J. A. Lateral view of the upper femur, showing periosteal reaction posteriorly.

SUMMARY

Two of five cases of acute, hematogenous osteomyelitis in the adult occurred in the femoral shaft, and were accompanied by pathological fractures—which are a common occurrence and difficult to prevent.

The clinical pictures of adult and childhood osteomyelitis are different.

There may be two distinct pathological types of adult infection, as evidenced by roentgenograms.

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EPIPHYSEAL PSEUDARTHROSIS *

BY HENRY MILCH, M.D., NEW YORK, N. Y.

From the Hospital for Joint Diseases, New York

Separation of epiphyses may occur as the result of trauma or as the consequence of a pathological process directly affecting the growing zone. In general, provided that excessive separation has not occurred, union, and even premature closure of the epiphyseal line, follows upon disappearance of the factors which caused the separation. Under certain circumstances, however, fusion may not take place, and a condition which may be called epiphyseal pseudarthrosis, or nearthrosis, arises. It has usually been considered as an interesting, but annoying, complication of infections or operative procedure about the hip joint. The writer's attention has been recently redirected to the study of septic hips by Badgley, Yglesias, Perham, and Snyder, which appeared in 1936. Their Table XI showed that among the complications were:

"Epiphysiolysis (produced by traction in 2 cases)... 9 cases

Nearthrosis (at epiphyseal line with fusion of

head to acetabulum or ilium)..... 8 cases"

Beyond this, but little attention has been devoted to the discussion of this condition in available medical literature, and no explanation of the pathogenesis of the condition has been found. This is the more to be regretted, because recognition of the condition may be of some value in explaining both the apparent failure of certain hip fusions, and the mechanism of development of so-called coxa anteverta,—the early phase of adolescent epiphyseal separation at the upper end of the femur³.

Occasionally, epiphyseal pseudarthrosis has been observed at the inferior femoral epiphysis, following ankylosis of the knee⁷; but most commonly it is found at the upper femoral epiphysis. Though the particular circumstances under which the condition appears may be different in the individual cases reported, the clinical picture in all seems to be dominated by certain common factors,—fixation of the epiphysis before closure of the epiphyseal line, and relative motion of the femoral shaft.

CASE I. R. B. (Case of Harry Sonnenschein, M.D.) has been under treatment for chronic osteomyelitis since the age of eleven (about 1917). At that time the child had suffered an infection of the right hip, which had been treated at another institution. Following this, the patient had suffered a recurrence for which treatment had been instituted. At the age of twenty-five, the infection in the lower end of the right femur had flared up. In 1937, at the age of thirty-one, the left hip became involved. In 1938, following an injury, symptoms appeared in the right knee. In 1941, the patient was again admitted for an acute exacerbation at the upper part of the right thigh.

Examination, clinically and roentgenographically, disclosed firm ankylosis of the left hip. On the right side, however, flexion of 30 degrees, abduction of 15 degrees, external rotation of 35 degrees, adduction of 5 degrees, and internal rotation of 7 degrees

* Presented before the Clinical Society of the Hospital for Joint Diseases, New York, N. Y., November 18, 1941.

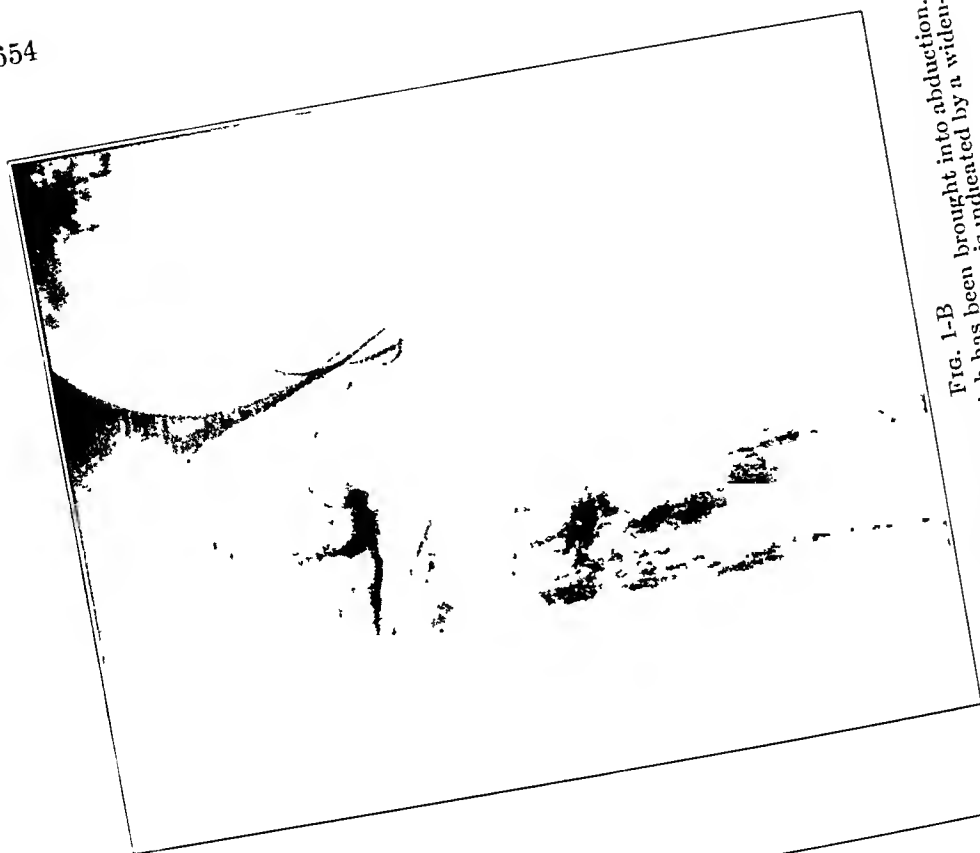


FIG. 1-B
The thigh has been brought into abduction. The head is fixed and the site of motion is indicated by a widening of the epiphyseal line.

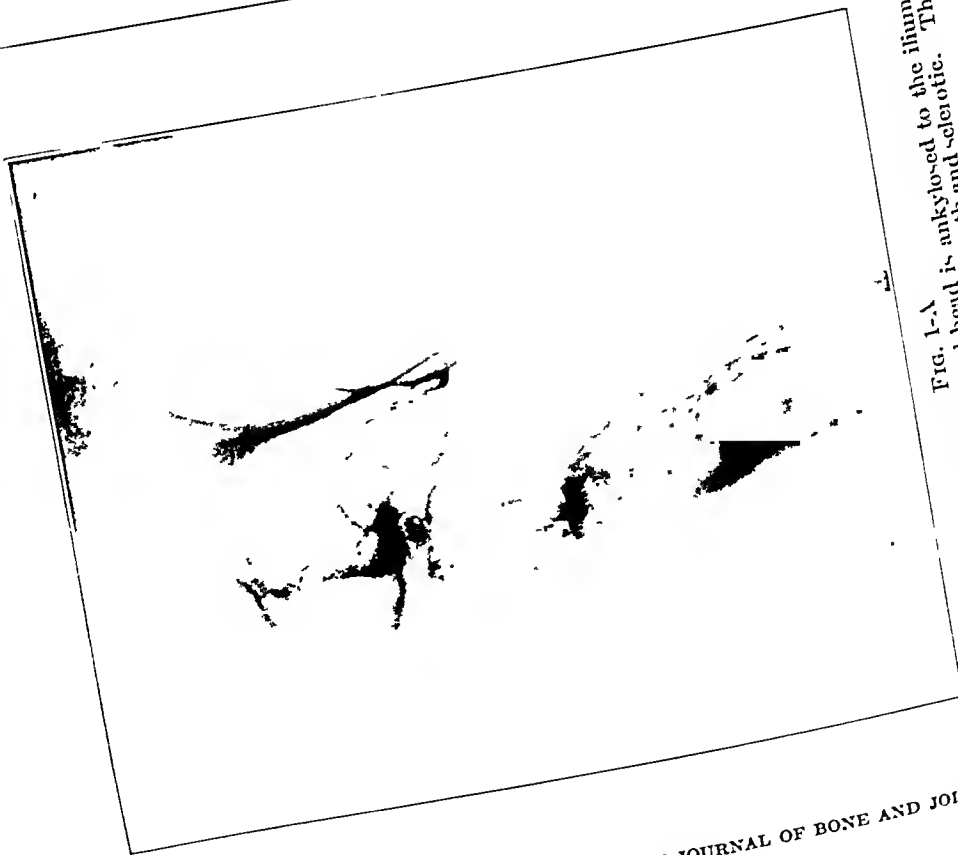


FIG. 1-A
The femoral head is ankylosed to the ilium. The margins of the epiphyseal line are smooth and sclerotic. The thigh is in adduction.

were noted. The roentgenogram (Fig. 1-A), disclosed ankylosis of the right femoral head, with a nearthrosis in the region of the old epiphyseal line. The margins of the nearthrosis were smooth and somewhat sclerotic. On abduction, the location of the motion was indicated by widening of the pseudarthrotic space (Fig. 1-B).

In consideration of the bony ankylosis which occurred later at the left hip, the pseudarthrosis on the right side must be looked upon as a particularly fortunate circumstance. From the history of the case, it would appear that the outcome must be predicated upon the belief that the ankylosis on the right side occurred before the epiphyseal plate had closed, while on the left side the ankylosis was coincident with, or took place after fusion of the epiphyseal plate. Special attention should be directed to the pyramidal shape of the capital epiphysis, which may resemble the result of a satisfactory shelf operation in a movable hip. If this is not recognized, the possibility of pseudarthrosis at the epiphyseal line may be overlooked. The following case is interesting from this point of view.

CASE 2. D. S. was first seen in the Hospital in 1929, at the age of two years. During the preceding year the patient had been immobilized in a plaster-of-Paris spica for a limp in the left hip. On admission there were characteristic clinical and roentgenographic signs of tuberculosis of the hip, and the treatment by plaster-of-Paris immobilization was continued. In January 1934, an extra-articular fusion of the hip was undertaken. In June 1935, a flexion-adduction deformity of the left hip necessitated the performance of a *directional* osteotomy. In January 1938, it was noted that flexion of the thigh was possible to 110 degrees and abduction to 10 degrees. This was attributed to failure of the fusion operation.

In February 1937, following a fall several hours earlier, the patient returned to the Hospital, complaining of pain in the right hip. A diagnosis of acute separation of the capital epiphysis was made. Under general anaesthesia, what appeared to be an anatomical reduction was accomplished, and a double spica was applied. Nevertheless, upon roentgenographic check-up, an incomplete correction of the deformity was noted, and a second unsuccessful attempt at manipulative reduction was made. The patient was fitted with an internal-rotation brace and was discharged, walking. At this time, extension of the hip to 180 degrees and flexion to 90 degrees was possible. A roentgenogram taken in March 1939 disclosed calcification of the epiphyseal plate on the right side. The left hip was described as disclosing an old destructive arthritis, with dislocation and the presence of a *bone bridge* superiorly. The upper end of the left femur and what was thought to be the joint space, are seen in Figure 2-A.

In July 1938 the patient again complained of pain in the left hip. Flexion of the femur was possible to 100 degrees and extension to 140 degrees. No rotation could be obtained, but abduction was present to 10 degrees. Clinically, there appeared to be motion in the left hip, but the tuberculous lesion did not appear to be progressing, either clinically or roentgenographically. Bed rest was advised, but, contrary to what might have been expected, the pain became worse. In January 1939, a roentgenogram showed essentially the same appearance as had been noted the previous March. When these roentgenograms were attentively studied, it was observed that the bone bridge described in the earlier roentgenogram really consisted of the fused femoral head. The site of motion was obviously in the subcapital region, and the neck of the femur pointed forward. In view of the epiphysiolysis which had developed on the right side, it seemed likely that the patient had developed an epiphysiolysis on the left side, but that, as a result of the fixation of the femoral head, a pseudarthrosis had developed at the epiphyseal line.

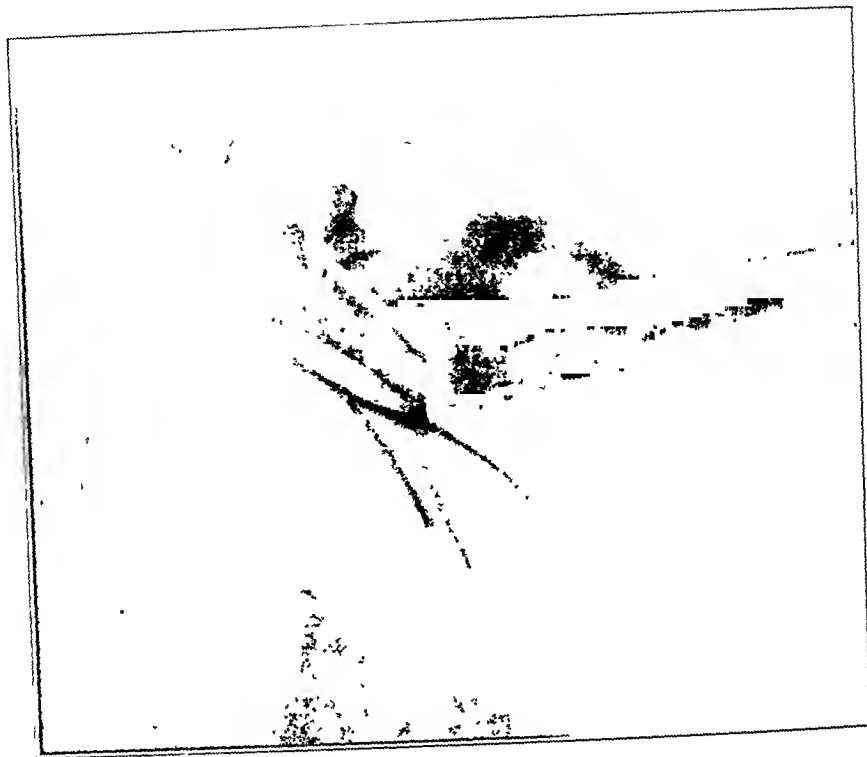


FIG. 2-B

Case 2. D. S. December 1940. Following a pelvic-support type of osteotomy to limit motion, the epiphyseal line is partially fused. All hip motion and all symptoms have disappeared.



FIG. 2-A

Case 2. D. S. March 9, 1939. The fusion of the head into the acetabulum is to be noted. The epiphyseal line appears to be open.

In March 1910, because of the underlying tuberculous disease, it was decided that an angulation *pelvic-support osteotomy* should be performed to limit motion⁵. The limb was immobilized in plaster for a period of four months. Subsequently all pain disappeared, even on weight-bearing. A roentgenogram (Fig. 2-B), taken in December 1940, showed union at the site of the osteotomy, with solid closure of the epiphyseal line. In April 1941, no motion at the left hip could be obtained.

In retrospect, this case seems to merit special attention. The patient was definitely not of endocrine *habitus*, and the epiphyseal separation on the right side appeared only after the fusion of the left hip,—possibly as a result of the additional stress caused by the hip tuberculosis on the left. On the right side, the relative limitation of external rotation accomplished by the brace was sufficient to lead to fusion at the epiphyseal line. On the left side, where the head was fused to the acetabulum, closure of the epiphyseal plate occurred only after osteotomy. It would appear, therefore, that two elements—motion of the head and motion of the shaft—enter into the pathogenesis of the condition. With regard to the joint line, motion between the head and pelvis is of critical significance; but, with regard to the epiphyseal line, it is the motion of the shaft relative to the head which is important. Such relative motion may occur against an ankylosed head, or against a movable, but relatively fixed, head. In the latter instance, it may lead to epiphysiolysis; in the former, to epiphyseal pseudarthrosis.

Other observers have noted the occurrence of motion in adolescent hips previously submitted to fusion operations. For the most part, the persistence of motion has been attributed to failure of fusion, and operative revision has not infrequently been advised and performed. The possibility that motion may develop at the epiphyseal line, after fusion of the head to the pelvis, does not seem to have been adequately stressed. However, recognition of the fact that such a condition may develop after an otherwise properly conducted fusion operation is of the utmost importance. Primarily, it indicates that opinion as to the success or failure of the operative fusion must be deferred until the site of motion can be accurately located. If it can be established that the motion takes place between the femoral head and the neck, it may be presumed with reasonable assurance that fixation, if not complete bony fusion of the head, has occurred at the joint line.

Since the existence of the pseudarthrosis must be predicated upon motion of the distal part, with respect to the relatively fixed proximal portion of the femur, certain indications with regard to treatment and prophylaxis of the condition appear evident. With regard to treatment of the condition, it seems that immobilization of the distal fragment is essential. Whether this be accomplished by plaster-of-Paris encasement, by drilling, by nailing, or by osteotomy may be immaterial, provided the fixation is maintained until closure of the epiphyseal line has occurred. With regard to the prophylaxis of the condition, it would appear that when fusion is indicated in the adolescent, intra-articular fusion alone

may be inadequate. Unless some means is provided for fixing the shaft until bony union has occurred between the capital epiphysis, the pelvis, and the upper end of the femur, the possibility of a pseudarthrosis developing cannot be confidently denied. This would seem to argue in favor of the combined intra-articular and extra-articular types of fusion in patients below the age of epiphyseal closure.

In both the cases above reported, it is to be noted that the pseudarthrosis was conditioned by mobility of the shaft and immobility of the capital epiphysis, but the full significance of fixation of the head was not completely appreciated until the following case was reviewed.

CASE 3. I. H. Was first seen in 1935, at the age of eleven years, with an epiphysiolysis of the *right hip* (previously reported)³.

"In February 1936, the child began to complain of pain in the left knee. Clinical examination disclosed no evidence of any limitation of motion, either in the knee or in the hip. A roentgenogram, taken on February 24, 1936, was reported as being 'radiographically negative.'

"On April 13, 1936, . . . the pain in the left hip was becoming more severe, and . . . a slight [hip] limp was noticed. Examination revealed no limitation of motion, but the roentgenogram . . . was reported as showing 'slight resorption of the neck of the femur adjacent to the epiphyseal line', . . . There is no slipping of the epiphysis at this time, but the x-ray is suspicious of early slipping."

Five days later a clinical diagnosis of acute epiphyseal separation was confirmed by roentgenogram.

Because of the recent nature of the displacement, closed reduction under general anaesthesia was undertaken. Roentgenograms taken at the time seemed to indicate satisfactory alignment, and a plaster-of-Paris spica was applied. Upon removal of the plaster, the epiphyseal plate *appeared* to be closed, but the hip had become completely stiff. In an effort to restore mobility, the thigh was manipulated under anaesthesia. A moderately satisfactory range of motion, presumably at the hip joint, was obtained. In an effort to increase this, a fracture of the lower end of the femur was incurred. Plaster was reapplied until healing of the femoral fracture had occurred; then an internal-rotation brace was applied, and the patient was permitted to walk.

In March 1937, it was noted that flexion of the left thigh was possible to 135 degrees; extension, to 150 degrees; internal rotation, to 20 degrees; external rotation, to 10 degrees; and abduction, to 20 degrees. Roentgenograms taken at this time showed no evidence of closure of the epiphyseal line. In fact, it appeared that the "satisfactory range of motion" previously accomplished had been obtained by reproducing the acute epiphysiolysis. In April 1938, the roentgenogram (Fig. 3-A) showed "moderate eburnation of the femoral neck at the original epiphyseal line. The capital epiphysis appears to be fused to the acetabulum."

In 1939, because of the persistence of pain and disability, a transpositional type of pelvic-support osteotomy⁵ was performed. Physiotherapy was instituted, and walking with the aid of crutches was permitted as soon as bony healing of the osteotomy had occurred. After several months, the most startling results were noted. The pain had disappeared, the gait had improved, and motion at the hip, appeared to be gradually returning. In December 1940 the patient could flex the hip to 70 degrees, extending it to 180 degrees, and abduct it to 25 degrees. External rotation was possible only to 5 degrees and internal rotation to 20 degrees. The roentgenogram showed "complete bony union at the site of the previous bifurcation osteotomy of the femur, with good alignment of the fragments. The femoral neck is moderately increased in width and is somewhat irregular. There is slight narrowing of the hip joint proper." But the most startling of all was that the epiphyseal line had closed by bony union and the pseudarthrosis had completely vanished (Fig. 3-B).



FIG. 3-B

Case 3. I. H. December 6, 1940. Following transposition ostectomy, the epiphyseal line has been closed by bony union. There is no fusion of the head to the acetabulum.



FIG. 3-A

Case 3. I. H. April 6, 1938. The head seems to be fixed in the acetabulum. The open epiphyseal line is to be seen. At the epiphyseal plate, the bone surfaces are sclerotic and rounded, and present the appearance characteristically seen in other pseudarthroses.

No specimen was removed, and the diagnosis of epiphyscal pseudarthrosis necessarily rests upon the clinical examination, and the roentgenographic appearance of the condition. However, the cupping of the capital epiphysis, and the rounding and sclerosis of the upper end of the femoral neck were so characteristic of the appearance seen in other types of pseudarthrosis that the diagnosis appeared amply justified. This seemed the more likely in view of the fact that, in specimens of the cartilage plate removed from other patients with adolescent epiphysiolysis, histological evidence suggesting the early phase of pseudarthrosis formation has been found².

The fact that motion at the hip persisted after union had occurred at the epiphyseal line seemed to indicate that the pseudarthrosis had taken place between a movable shaft and a *relatively* fixed femoral head. The fact that at one time the head appeared fused to the acetabulum and the epiphyseal line was open, while at another the epiphyscal line appeared closed and the head was clearly free, suggests that the characteristic appearance of pseudarthrosis seen at the upper end of the neck of the femur betrayed this to be the site of motion. Naturally enough, the possibility of applying this concept of relative fixation to adolescent epiphysiolysis presented itself.

A number of different hypotheses have been advanced to explain adolescent epiphysiolysis. At the present time, informed opinion attributes the condition to forces which may be roughly classified as those which amplify external rotation of the shaft (such as overweight, trauma, or increasing obliquity of the epiphyseal plate), and those which decrease the resistance of the cartilage plate (such as endocrine or other metabolic disturbances). Whichever one of these etiological factors may be considered as *the* cause of epiphysiolysis, none seems to offer a completely satisfactory account of the pathogenesis of the condition. It has been realized that any valid description of the mechanism would have to include a force which would act upon the head, in a direction contrary to that made necessary by the progressive anteversion of the upper end of the femoral neck. In an attempt to remedy this defect, the resistance of the ligamentum teres femoris has been cited as a counterforce. This does not appear to have made a deep impression upon those interested in a solution of the problem of epiphysiolysis. It has seemed highly probable that, if any anatomical interference with motion of the femoral head contributed to the development of epiphysiolysis, it would have to be of greater magnitude than the resistance offered by the ligamentum teres femoris.

The existence of such a force was brought to the writer's attention during a demonstration of the anatomy of the hip joint. The iliopsoas tendon is described as lying over the capsular ligament of the hip joint,—that is, presumably over both the head and neck of the femur. However, when the relationship of this tendon was attentively examined, it was found to lie quite specifically over only the descending arm of the

Y ligament of Bigelow. In over twenty cadavera in which this joint was investigated, the tendon was found to have made a longitudinal groove in the capsule, but this was always confined to a narrow area along the medial portion of the capsule. In no instance was the tendon found to cover the neck of the femur. In external rotation, when the anterior portion of the head was directed forward, the tendon lying upon the descending arm of the capsule covered only the area of the original capital epiphysis. Lateral to this, the neck of the femur was covered by the capsule, which arched across from the region of the head to its insertion near the base of the femoral neck.

When the extended thigh was externally rotated, the femoral head moved partly out of the acetabulum, pushing before it the iliopsoas tendon. The limit of external rotation appeared to be determined by the tension of the iliopsoas tendon and not by the capsule, which was still relaxed when motion was checked. It was only after the iliopsoas tendon was cut across, that further external rotation was possible up to the point where the pubofemoral portion of the capsule became taut. At this limit there was, between the anterior portion of the neck and the taut capsule, a space within which further motion of the separated neck easily would have been possible, even after all forward motion of the head had been stopped.

This disposition of the psoas tendon offered a rational anatomical explanation for the development of the counterforce necessary in the pathogenesis of epiphysiolysis. Viewed as a mechanism for relative fixation of the femoral head, it served to establish a correlation between epiphysiolysis and epiphyseal pseudarthrosis⁶. Both occur before the epiphyseal line closes, and both are characterized by mobility of the long lever arm of the femoral shaft against a relatively immobilized capital epiphysis. Both can be cured by immobilization of the shaft with respect to the capital epiphysis. In fact, it appeared not unreasonable to consider epiphyseal pseudarthrosis as a chronic form of the condition more commonly seen as adolescent epiphysiolysis.

SUMMARY

Epiphyseal pseudarthrosis at the hip has been observed under the following conditions:

1. After operative fusion of the hip,
2. After inflammatory ankylosis of the hip,
3. As a sequel to adolescent epiphysiolysis.

It may occur in any condition in which the capital epiphysis becomes ankylosed before closure of the epiphyseal plate occurs. Mechanically, mobility of the shaft of the femur, with respect to a *relatively* fixed head, is essential to the appearance of the condition. Successful therapy is based upon immobilization of the distal fragment in relation to the proximal fragment.

Recognition of the condition is of paramount importance in explain-

ing some cases of apparent failure after an attempt at operative fusion of the hip. Appreciation of its cause throws interesting light on the pathogenesis of adolescent epiphysiolysis.

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LEGG-PERTHES DISEASE

A COMPARATIVE STUDY OF VARIOUS METHODS OF TREATMENT

BY LOUIS J. LEVY, M.D., FORT WORTH, TEXAS, AND
P. M. GIRARD, M.D., DALLAS, TEXAS

From the Texas Scottish Rite Hospital for Crippled Children, Dallas

In 1909, Legg first described epiphysitis of the femoral head as a clinical entity. Since that time the treatment of choice has been a subject of considerable controversy. The very fact that there have been so many different methods of treatment described, reveals the lack of unanimity of thought on the subject. In an attempt to evaluate the various methods of therapy, 102 cases of Legg-Perthes disease were analyzed. Eleven of these cases were bilateral, so that in all a total of 113 hips were studied.

In analyzing the results of treatment, both clinical and roentgenographic findings were taken into consideration. The roentgenographic results were found to be the more reliable criteria. Early in the course of the disease, the symptoms are often more marked than the roentgenographic changes would warrant, whereas in the healed condition, a good clinical result is frequently associated with a poor roentgenographic result. Often in a patient showing a good clinical, but a poor roentgenographic result, limitation of motion and pain from traumatic arthritis will develop at a later date; or painful instability may develop. For this reason, in the evaluation of these cases, more credence has been given to the roentgenographic results than to the immediate clinical results.

The roentgenograms were studied for the amount of flattening and fragmentation of the head, and the amount of broadening of the neck. The most essential evaluating factor was found to be the amount of flattening. but, in the final analysis, this had to be qualified with a note concerning the regularity and shape of the head.

The cases were divided into eight groups according to the type of treatment each received. Six of the cases were treated by miscellaneous methods not fitting into any of the larger categories, so the total number discussed and tabulated is ninety-six. Each of the eight groups will be discussed separately:

1. *No Treatment*

There were sixteen patients in this group, who were either not seen until after the disease had completely healed, or who were followed through the course of the disease with no treatment being instituted. These, for the most part, are patients who were seen near the beginning

TABLE I
RÉSUMÉ OF RESULTS OF TREATMENT

Type of Treatment	No. of Cases	Average Height of Head as Compared with the Normal (Per Cent.)				Clinical Results (Per Cent.)			Duration of Phases (Months)	
		When Therapy Started	At Maximum De-struction	In Final Results	Excel-lent	Good	Fair	Poor	Degen-erative	Regen-erative
1. None.....	16	100	42	48	0	19	25	56	23	16.5+
2. Brace.....	21	60	42	53	9.5	9.5	48	33	16	17
3. Brace and elevated shoe.....	10	81	52	54	0	40	20	40	21	20
4. Cast, brace and elevated shoe.....	4	54	53	59	25	50	25	0	18	19.5
5. Drilling, cast, brace, and elevated shoe.....	8	44	45	57	12.5	62.5	12.5	12.5	16	15
6. Cast.....	9	57.5	38	38	0	11	22	67	19	21
7. Cast and brace.....	13	61	49	55.5	15.5	23	38.5	23	16.5	16.5
8. Elevated shoe and crutches.....	15	64	50	60	13.3	53.4	20	13.3	16	16

of the series when it was felt that treatment did not materially alter the course or result of the disease.

In presenting these cases, the original condition of the head must be considered as normal (100 per cent.). At the point of maximum destruction, the head was only 42 per cent. of its original height, and in the final result it had regenerated to only 48 per cent. of its normal height. No patient in this group had an excellent result. The results were good in 19 per cent., and fair in 25 per cent. In 56 per cent., the broadening, distortion, and irregularity of the head gave poor results (Table I).

In the clinical classification of these cases, *excellent* refers to those patients of whom the roentgenogram shows a femoral head with at least 70 per cent. of its normal height, and who had full range of motion of the hip clinically, no shortening of the leg, and no pain. *Good* results were in those with well-rounded heads of at least 50 per cent. of normal height, and who clinically had less than one centimeter of shortening, only slight limitation of motion, and no pain or instability. The *fair* results were in those in whom the head was less than 50 per cent. of normal height, not well rounded, and showing roentgenographic evidence of possible instability later, in spite of a clinically stable hip at the time of examination. In this group, the shortening was less than two centimeters. Hip motion was at least 50 per cent. of normal, with only occasional slight pain on weight-bearing. The *poor* results were in those in whom the roentgenograms showed marked flattening and distortion of the head, a sloping acetabulum with evident instability, or a lateral prominence of the head requiring reconstruction. Although many of these patients with poor roentgenographic results may show good clinical results immediately after healing, it has been found that a gradual limitation of motion will usually develop. Traumatic arthritis and increasing pain and instability will appear later in life.

In the group of cases which had no treatment, the degenerative phase (length of symptoms plus length of time under treatment until regeneration began) was twenty-three months. Since many of the cases in this group were seen for the first time late in the course of the disease, figures for the duration of the regenerative phase are inaccurate. From data obtainable, however, it is evident that this phase is well in excess of sixteen and one-half months.

2. *Brace*

Twenty-one patients were treated with a brace of the Thomas-ring, caliper type, with frequent adjustments to try to maintain ischial weight-bearing. The findings coincide with those of other writers⁵, that this is a very inadequate type of treatment. When the average patient of this group was first seen, the femoral head was 60 per cent. of normal height. During the degenerative phase, the head was flattened to 42 per cent., and the final result showed the head to be 53 per cent. of normal height. The results were excellent in 9.5 per cent.; good, in 9.5 per cent.; fair, in 48 per

cent.; and poor in 33 per cent. (Table I). In this group, the average degenerative phase lasted sixteen months, and the regenerative period required seventeen months.

3. *Brace and Elevation of the Opposite Shoe*

Ten patients were treated with a non-weight-bearing brace on the involved leg and an elevated shoe on the opposite foot. The brace was of the ischial-ring, weight-bearing type. The side bars of the brace were extended to a walking sole two to three inches beyond the foot on the involved side, so as to prevent weight-bearing on the femoral head. The opposite shoe was elevated accordingly. The results in this group were very similar to those obtained by treatment with a brace only. The average case was seen fairly early, with the femoral head 81 per cent. of normal height. During the course of treatment, the flattening progressed until the head was 52 per cent. of normal, and improved only to 54 per cent. In this group no patient could be said to have an excellent result. In 40 per cent. the results were good; in 20 per cent., fair; and in 40 per cent., poor. The degenerative phase lasted twenty-one months. The follow-up results in this group were too incomplete for definite figures, but the regenerative phase was approximately twenty months.

4. *Cast, Brace, and Elevation of the Opposite Shoe*

Four of the patients were treated with a spica cast for four months; this was followed by a non-weight-bearing brace on the involved leg and an elevated shoe on the opposite foot. Although the number of cases in this group was quite small, the significance of it must be considered. By merely adding a preliminary period of immobilization and rest, the treatment by brace and shoe-elevation (as in Group 3) gave much better results. The initial height of the femoral head in the average case was 54 per cent. of normal. The head flattened to 53 per cent., and improved to 59 per cent. The final clinical results were excellent in 25 per cent. of the cases; good, in 50 per cent.; and fair, in 25 per cent. None of the patients had poor results. The degenerative phase lasted eighteen months, and the regenerative phase was nineteen and one-half months (Table I).

5. *Drilling, Cast, Brace, and Elevation of the Opposite Shoe*

Eight patients were treated by multiple subcutaneous drilling through the neck into the femoral head, as described by Bozsán.^{1,2} This was followed by a spica cast for four months, after which a non-weight-bearing brace was applied to the involved leg, and an elevated shoe to the opposite foot. Most of the patients selected for this type of treatment had considerable head destruction when first seen. The average femoral head in this group at onset of treatment was only 44 per cent. of normal height. Under this regime, flattening progressed only to 43 per cent., and improved until the head was 57 per cent. at the end of the regenerative phase. The clinical results were excellent in 12.5 per cent. of the cases;

good, in 62.5 per cent.; fair, in 12.5 per cent.; and poor, in 12.5 per cent. The degenerative phase lasted sixteen months, and the regenerative phase, fifteen months (Table I).

6. *Cast*

Nine of the earlier patients in this series were treated by recumbency in plaster casts. The patients were placed at bed rest in a spica cast for a period of time varying from two to eight months, after which they were allowed up with crutches with gradually increasing weight-bearing. At the time this treatment was used, it was intended more to relieve the initial muscle spasm and clinical signs than to furnish a method of insured rest and immobilization until the head had regenerated. For this reason, few of these cases had advanced very far into the regenerative phase when weight-bearing was resumed. During the period of recumbency, the femoral heads usually retained their height and structure fairly well. As soon as activity was resumed, however, flattening and destruction rapidly occurred. In the average case, the femoral head was 57.5 per cent. of normal height when first seen. During the course of treatment flattening progressed until the head was only 38 per cent., and improved practically none from this point. The final clinical and roentgenographic results were very unsatisfactory: No patient had an excellent result. The results were good in 11 per cent.; fair, in 22 per cent.; and poor, in 67 per cent. The degenerative phase lasted nineteen months, and the regenerative phase lasted twenty-one months (Table I).

7. *Cast Followed by Brace*

This group of thirteen patients were treated by recumbency in a plaster spica for an average period of four months, after which a Thomas-ring, caliper type of brace was applied to the involved leg. The results obtained were intermediate between those with a cast alone, and those which were treated with a cast followed by a non-weight-bearing brace and elevated shoe. In this group, the femoral head when first seen was 61 per cent. of normal height; it flattened to 49 per cent. under treatment, and improved to 55.5 per cent. The final results were much better than those treated with a cast only, — excellent, in 15.5 per cent., good, in 23 per cent.; fair, in 38.5 per cent.; and poor, in 23 per cent. The degenerative and regenerative phases averaged sixteen and one-half months each.

8. *Elevation of the Opposite Shoe and Crutches*

Fifteen patients were treated by placing an elevation of approximately two inches under the shoe on the well leg. The patient then walked with crutches with the involved leg hanging free, and without weight-bearing. This is the most recent group treated, and although the follow-up is limited as to time, it appears to be a very satisfactory method. The average case was seen with the femoral head 64 per cent. of normal height. During the course of treatment, flattening progressed to 50 per

cent., and improved to 60 per cent. The clinical results were excellent in 13.3 per cent. of the patients; good, in 53.4 per cent.; fair, in 20 per cent.; and poor, in 13.3 per cent. Since quite a number of these results were based on femoral heads still in the regenerative phase, it is probable that the final result will be even better than here represented. The degenerative and regenerative phases were approximately sixteen months each.

DISCUSSION

Of the 102 cases studied, ninety-three (91 per cent.) were males, and nine (9 per cent.) were females. Eleven cases (10 per cent.) were bilateral. The age when the patients were first seen varied from three to thirteen years, averaging eight and six-tenths years. Most of the patients were seen fairly early after the onset of the disease, and some were followed for six to eight years, giving a fairly accurate follow-up survey.

The average properly treated case of Legg-Perthes disease was found to run a course of approximately two and one-half years. If the treatment is improper, or lacking entirely, the course may be prolonged to as much as four years. In this disease, there are two phases—the degenerative and the regenerative. In the average well-treated case, the phases are approximately the same length, and each lasts about sixteen months. As Gill has noted, the change from one phase to the other is fairly abrupt. The results obtained depend on:

1. How early in the course of the disease the treatment is started;
2. The type of treatment used.

Usually, when a case is seen early and is given proper treatment, the head does not go on to such extensive flattening and fragmentation, and a better result is obtained in a shorter time. On the other hand, the case that is seen late and is improperly treated, or not treated at all, frequently has a prolonged course, and terminates with a flat, broad, irregular, distorted head.

In the opinion of Legg⁸ and other early writers, the end results in cases of epiphysitis which received no treatment, were as good as those in the cases which were treated. This opinion is not shared by most of the present-day writers⁴, and certainly does not correspond to the results seen in this study. The poorest results obtained were in the group which received no treatment.

Ideally, the treatment of Legg-Perthes disease should be started very early, when the changes are evidenced as only an increased density in the femoral head. Danforth, Eyre-Brook, Gill, and others prefer to treat such a case by placing the patient in bed with or without traction on the involved extremity until healing is complete. This is probably the best method of therapy from the standpoint of results in the hip. It is difficult, however, to get the full cooperation of either the patient or his parents for such prolonged recumbent treatment. This is particularly true in a condition which is so devoid of pain and other tangible symptoms. It is difficult to care for a patient in traction at home, and hospitalization

for such a prolonged period is often financially prohibitive. Therefore, whereas treatment in recumbency may be the best type to follow when it is feasible, it certainly cannot be applied to a large percentage of cases.

In searching for a substitute method of treatment which would give satisfactory results, the various methods previously mentioned were tried. From studying the results it becomes readily apparent that, if some form of non-weight-bearing treatment is started, it should be continued until the regenerative phase is completed. Very poor results were obtained in the group treated with immobilization followed by weight-bearing without additional support. Similarly poor results were seen from other methods when the patient would not cooperate in using non-weight-bearing appliances. In such cases it is quite reasonable to assume that the preliminary period of non-weight-bearing serves to decalcify the involved structures sufficiently to *encourage* flattening when weight-bearing is resumed too soon. Even in the regenerative phase of the disease, if the appliances are discontinued too soon, further flattening will occur.

The efficacy of multiple drilling as an adjunct to treatment is still a controversial subject. It does not seem to shorten the course of the disease, but it does seem to favor restoration of the femoral head in cases with considerable destruction. As seen in Table I, patients treated with multiple drilling had the greatest restoration of head height (14 per cent.). In this series, drilling was primarily used on those patients who had marked flattening and fragmentation of the femoral head when they were first seen; however, two patients were treated by drilling fairly early in the course of the disease, and both of these obtained good results.

TREATMENT OF CHOICE

The simplest and most effective method of treatment used was elevating the shoe on the well leg, and having the patient walk with crutches without weight-bearing on the involved leg. This type of treatment is readily available, inexpensive, and with reasonable cooperation will give good results. Since it is an ambulatory method of treatment, it is more readily accepted than recumbent or more encumbering types. The patient must be impressed, however, with the importance of walking on the crutches and well leg, and he must not walk or kneel on the involved leg. If the patient has only a moderately restricted range of motion without muscle spasm, this treatment is started immediately. If there is an adduction contracture or considerable muscle spasm, the patient is treated with preliminary traction for several weeks, until muscle relaxation and abduction are obtained. The hip is then immobilized in an abduction spica for three to four months, after which the patient is allowed up on crutches with an elevation under the well leg and no weight-bearing on the involved hip. Relatively few of the patients have sufficient hip deformity to warrant the preliminary traction and cast treatment.

It is felt that in cases of Legg-Perthes disease treated as outlined

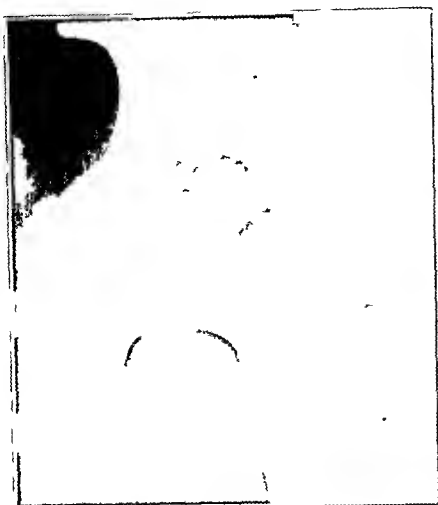


FIG. 1



FIG. 2



FIG. 3



FIG. 4



FIG. 5

Illustrations represent the course of a typical case of Legg-Perthes disease under treatment.

Fig. 1: August 1938. There is increased density in the epiphysis, but no flattening has occurred as yet. Treatment was started at this stage.

Fig. 2: March 1939.

Fig. 3: January 1940. Flattening had progressed to 50 per cent.

Fig. 4: September 1940.

Fig. 5: March 1941. The head had improved to 70 per cent. of the normal height.

the roentgenographic and clinical results compare favorably with those obtained by treatment with prolonged bed rest and traction (Figs. 1-5).

If the patient has bilateral hip involvement with the disease in an active state in both hips, the only effective method of treatment is complete bed rest. In most cases with bilateral involvement, however, one hip is involved some time before the other is affected, and the first hip may even be completely healed before the second one is involved. If both hips are not simultaneously involved, the elevated shoe and crutch treatment may be used satisfactorily.

A disabling feature which occasionally appears in the regenerative phase of this condition is a prominence of the lateral portion of the femoral head projecting beyond the superior acetabular rim. This prominence is the result of weight-bearing on the softened head, and is found usually in those patients who were seen for the first time relatively late in the course of the disease. It results in a mechanical block to abduction and frequently in a distortion of the acetabulum itself. When such cases are seen before the head is too well organized, they are treated with traction to obtain abduction, thereby placing the lateral prominence back under the acetabular roof. After this, the patients are immobilized in an abduction spica cast, extending only to the knee on the involved side. A two-bar caliper brace with a free knee joint is incorporated into the thigh portion of the cast, so as to allow knee motion while still protecting the leg from falls or missteps. In this apparatus, the patient is allowed up with full weight-bearing, thus allowing the acetabulum to remold the femoral head.

If a patient with a lateral prominence of the femoral head is first seen after the head has completely regenerated, a reconstruction operation is necessary.

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FIG. 1-A



FIG. 1-B

1: For correcting adduction, whether through Chopart's joint, or a metatarsus varus, hinges are placed at the center of the instep and at the anterior end of the plantar surface of the heel.

2: For correcting the heel varus, hinges are placed at the center of the instep and just above the center of the tuberosity of the calcaneum.

3: For correcting equinus, hinges are placed just distal to the tips of the malleoli.

4: When the maximum correction has been obtained, a retention cast is applied.

removal of the cuff for further correction the following week. Being adherent, the cast cannot be kicked off nor will it rotate on the leg. Keeping the plaster below the knee obviates soiling of the cast, with consequent skin irritation, and permits knee motion.

Older children can be fitted with rubber-tipped walking irons, even where both feet are being treated. Walking is allowed as soon as the plaster is hard. The easier transportation facilitated by this iron, enlists a heartier cooperation on the part of the parents, often saves hospital admission, and permits the children their regular activities.

operations to complete correction, after the main obstacles have been removed surgically.

ILLUSTRATIVE CASES

CASE 1. J. V. (Hospital No. 216075), came to the Clinic in May 1938, when four weeks of age, with a left equinovarus of severe grade. Wedging plasters were applied. Since this foot yielded readily, only two wedgings were necessary in each of the three planes, and overcorrection in all planes was achieved in nine weeks. A retention plaster was applied for eight weeks. With removal of the retention cast, the mother was instructed in manipulation. At the age of one year, when he started to walk, he was fitted with straight-last shoes with lateral heels and sole wedges on the left. At the age of two, he was allowed to wear unwedged shoes, since his foot was apparently normal. On May 16, 1941, his left foot was slightly shorter than the right, and the left calf was slightly less stout than its normal fellow. The foot could be dorsiflexed to 75 degrees, had good voluntary evertor action, and the gait was normal. The follow-up was two years and eight months.

CASE 2. B. C. (Hospital No. 216245), came to the Clinic June 1938, at the age of one month, with a bilateral equinovarus partially correctable on manipulation. Wedging plasters were applied. The foot proved slightly resistant, and the wedging in the first plane had to be repeated. Overcorrection was obtained in all three planes at the end of thirteen weeks. After eight weeks further in retention casts, the plaster was removed, and the mother was instructed in manipulation of the feet. When the patient started to walk, he was fitted with straight-last wedged shoes. When these were worn out, he was given normal unwedged shoes which he has worn since. When seen on May 16, 1941, his gait was normal, and examination of the feet revealed no stigmata of his original deformity, except for the dimple over the outer aspect of the talar heads.

CASE 3. E. C. (Hospital No. 180352), was born in 1931, and from birth until the age of thirteen months was treated elsewhere, with corrective plaster casts, for right equinovarus. After a relapse in his second year, he was given a further course of treatment in plasters, lasting three months. This was followed by a tenotomy. The patient always walked pigeon-toed on his right foot, and wore off his shoes on the outside. At the age of four he came to the New York Orthopaedic Dispensary and Hospital Club-Foot Clinic. Examination showed a slight fixed varus of the heel, slight adduction through Chopart's joint, and 10 degrees of equinus deformity. Wedging plasters were applied, and, when overcorrection was completed in all planes, the patient was placed in a retention plaster for eight weeks. He was in plaster a total of twenty weeks. He was then fitted with straight-last wedged shoes which he wore for two years before discarding them for normal shoes at the age of seven. When last seen at the age of ten, the right foot was normal, except that it was slightly shorter than its fellow, and the right calf measured one inch less in circumference.

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PERSISTENT OLECRANON EPIPHYSES IN ADULTS

BY D. H. O'DONOGHUE, M.D., AND L. STANLEY SELL, M.D., OKLAHOMA CITY,
OKLAHOMA

A very careful search of the American and English literature has failed to reveal any reports of a case similar to one encountered in the authors' practice a few months ago, and this is believed to be sufficient justification for publishing a short résumé of the case history, and a very brief review of foreign literature on the same subject. The following report is submitted, therefore, first, to record in American literature what appears to be a rare anomaly at the elbow joint; and, second, to call attention again to the medicolegal significance of persistent epiphyses in areas exposed to trauma.

In childhood, the olecranon is entirely cartilaginous, and the bony olecranon process is formed by growth cephalad from the shaft of the ulna. The olecranon epiphyseal center usually appears in the cartilaginous cap at the age of nine or ten, and ossifies from the tip downward, normally uniting with the shaft at the age of fourteen. From available reports, it appears that epiphyseal separations at the olecranon are rare injuries. Eliason, in reporting 138 fractures in this immediate region, found only three epiphyseal separations, and these were in children under fourteen years of age.

Standard texts of roentgenology offer very little data on persistent olecranon epiphyses, and in the American literature no reference to this subject was found. However, there appears to be a considerable degree of confusion between a true unfused olecranon epiphyseal plate, and the so-called patella cubiti. There are several references in both the German and American literature to patella cubiti, which must not be confused with the entity here reported. It appears that Kienböck, in 1903, was the first to describe patella cubiti as an anomaly of the elbow joint. However, Köhler makes the clearest differentiation between the two, with a very definite description of both processes: first, true patella cubiti, embryonic in origin, a completely isolated piece of bone, articulating and mobile, and truly an accessory bone; second, simple persisting epiphysis, that is, a persistent epiphyseal plate, most commonly found on both sides, and having a tendency to occur in families.

The case reported falls definitely in the second group. In this particular instance, trauma called attention to the open epiphyseal plate on one side. Further roentgenograms revealed not only a persistent epiphyseal plate in the olecranon on the uninvolved arm, but also bilateral tripartite patellae. Roentgenographic study of other significant bones throughout the skeleton failed to reveal any further anomalies.

O. J. P., a white male, thirty-one years old, was first seen on October 14, 1941, following an injury to the right elbow. While loading pipe in an oil field, the patient was

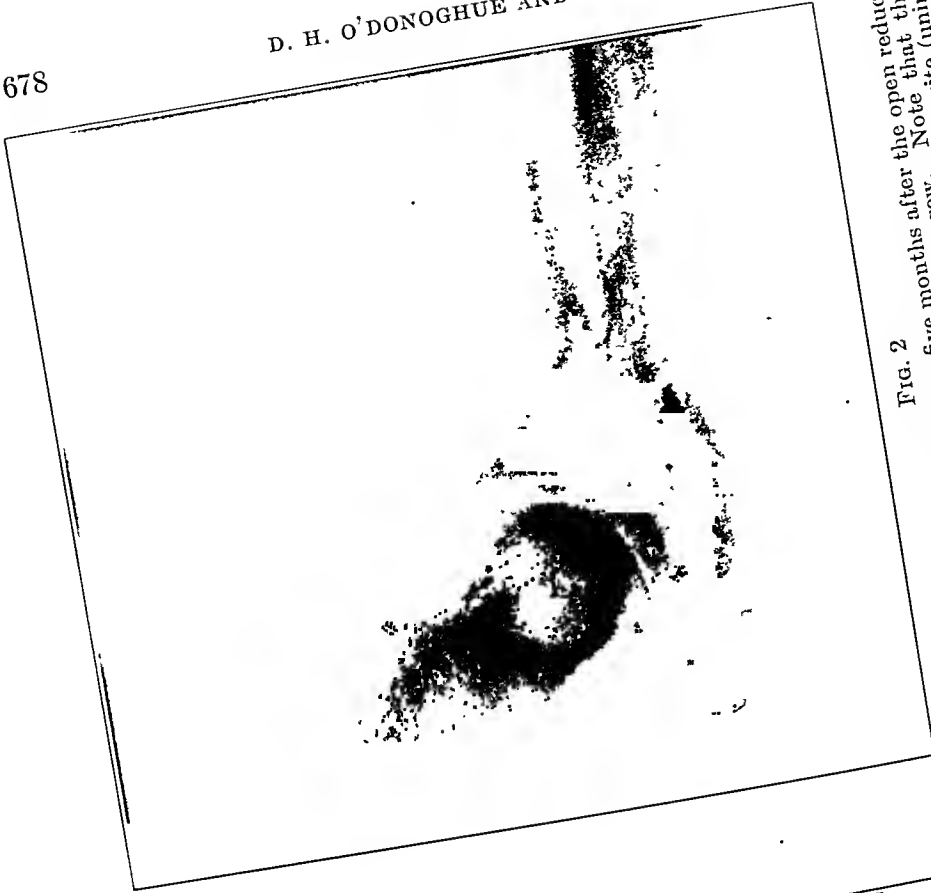


FIG. 2

Roentgenogram of injured elbow five months after the open reduction and internal fixation with a vitallium screw. Note that the epiphyseal plate does not differ significantly from the opposite (uninjured) side in spite of the trauma incident to the fracture and open reduction.

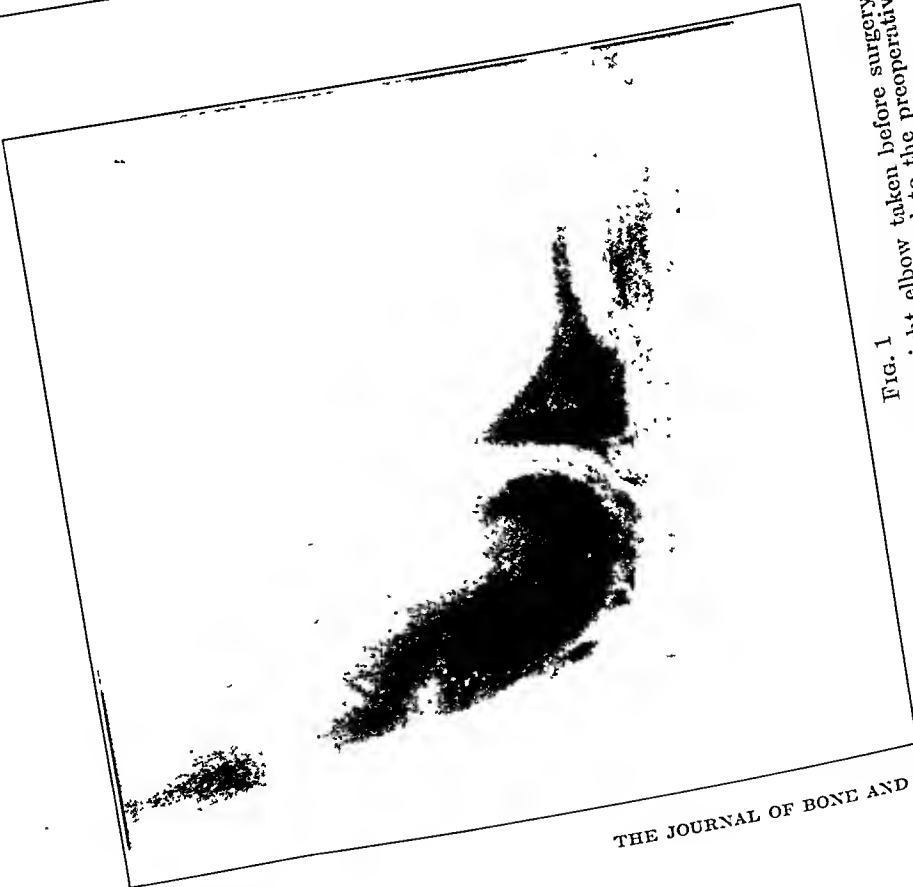


FIG. 1

Original roentgenogram of the right elbow taken before surgery. Note the smooth wavy fracture line which led to the preoperative diagnosis of fracture through an unclosed epiphyseal plate.

struck across the right elbow by a loose piece of pipe. He had immediate pain and disability, and was taken to a local doctor, who applied a splint and sent the patient in for further treatment. Roentgenographic examination revealed a complete fracture through the olecranon process, apparently at the site of the old epiphyseal plate which was still open. This opinion was confirmed at operation, at which time the fracture site was seen to be definitely cartilaginous, and no raw bleeding bone was encountered, as is ordinarily seen in a fresh fracture. Anatomical reposition was obtained, and the fragment was held by one vitallium screw. The wound healed *per primam*, and two months after the operation, the patient was back at work, with no pain and only a few degrees of limitation of motion. Three months following the operation, the patient had a range of motion from 30 to 170 degrees, as compared with 50 to 175 degrees in the uninvolved elbow.

In spite of the trauma to this epiphyseal plate resulting from both the fracture and the open reduction, it still remains open at the last roent-



FIG. 3

Roentgenogram of the left (uninjured) elbow showing an open olecranon epiphysis. The patient had never had any symptoms in regard to this elbow, and had a full range of motion with normal strength and function.

genographic examination, five months after operation, and does not differ significantly from the uninjured plate on the opposite side. It was not possible to examine either the patient's father or brother in order to confirm Köhler's statement that this condition tends to occur in families.

In conclusion, the nature of this condition was suspected from the preoperative roentgenograms, and actually confirmed at the operation, at which time there was no fresh fracture site, but definite cartilaginous material. No effort was made at operation to close the epiphysis, other than by fixation with a vitallium screw. It is possible that this condition

is much more common than would be indicated from a search through the literature, and it would be interesting to hear from other physicians who have encountered a similar condition.

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THE DIAGNOSIS AND TREATMENT OF KYPHOSIS DORSALIS JUVENILIS (SCHEUERMANN'S KYPHOSIS) IN THE EARLY STAGE

BY DR. ROBERT S. SIMON, JERUSALEM, PALESTINE

*From the Department for Corrective Gymnastics of the Straus Health Centre,
Hadassah Medical Organization, Jerusalem*

During the last few years, in the Department for Corrective Gymnastics of the Straus Health Centre, Jerusalem, hundreds of children have been treated partly by corrective posture exercises and partly by intensive orthopaedic gymnastics. They were referred to the Department by the school doctors, because of bad posture, and were usually between the ages of eight and ten years. Examination showed a slightly rounded back, sometimes with a mild scoliosis, but with no fixation of the deformity.

These children may be divided into three groups. Group I represents the majority of children, and comprises those patients who, following a course of one year, were dismissed either improved or healed. Group II is composed of a small number of patients, whose condition remained unchanged, due in part either to irregular attendance or to lack of cooperation; this group also includes children with rachitic deformities. Group III, about 1 per cent. of the cases, is composed of those children whose condition became worse in spite of, or possibly on account of, the intensive gymnastics. It is with the third group that this paper is primarily concerned.

In the patients who showed impairment of the condition after a year's treatment, stiffness in the lower thoracic spine was noted. Following a course of more intensive gymnastics, which ordinarily would yield satisfactory results, the back became more bowed and the spine more extensively ankylosed. Roentgenographic examination showed the well-known signs of kyphosis dorsalis juvenilis,—flattening of the intervertebral discs, Schmorl's cartilaginous nodules, wedge-shaped vertebral bodies, and destruction of the epiphyses.

According to Scheuermann, the primary cause of the disease is disturbance of the epiphysis; while it was Schmorl's contention that the etiological factor is prolapse of the nucleus pulposus into the spongiosa through the weakened cartilage, especially where there are embryonal rests of the chorda dorsalis. In this way the disc becomes flattened and its turgor is disturbed, leading to a lesion of the epiphysis. All of these facts are demonstrated roentgenographically only after the disease has become quiescent; the prolapse of the nucleus pulposus is shown by the reactive osteoid tissue, which prevents further penetration, and the lack of turgor is explained by the shallowness of the intervertebral spaces.

Most authors have observed the disease in patients between the ages of fifteen and twenty-two years; Scheuermann's youngest patient was

thirteen years old. In some of the patients observed by the author, however, the disease began much earlier. Since healing and the prevention of pronounced and fixed kyphosis are possible only in the primary stage of the disease, an early diagnosis is of the utmost importance.

Following the theory of Schneider that there is some relationship between diseases of the epiphysis and vitamin-A deficiency, the eyes of all the children were examined for hemeralopia and xerophthalmia. It was found that most of the children with kyphosis dorsalis juvenilis suffered from slight hemeralopia, and xerophthalmia was found in two of the group from nine to thirteen years of age. In a parallel group of children with poor posture only, practically no hemeralopia was found, and no child with xerophthalmia.

The blood serum of these children was examined for carotene beta and vitamin A, and it was found that most of the children with kyphosis dorsalis juvenilis showed a lack or deficiency of vitamin A. In the blood-serum test for vitamin A, the average for the younger group with kyphosis dorsalis juvenilis was five international units, and for the older group, 130; the average for the total group with poor posture only was

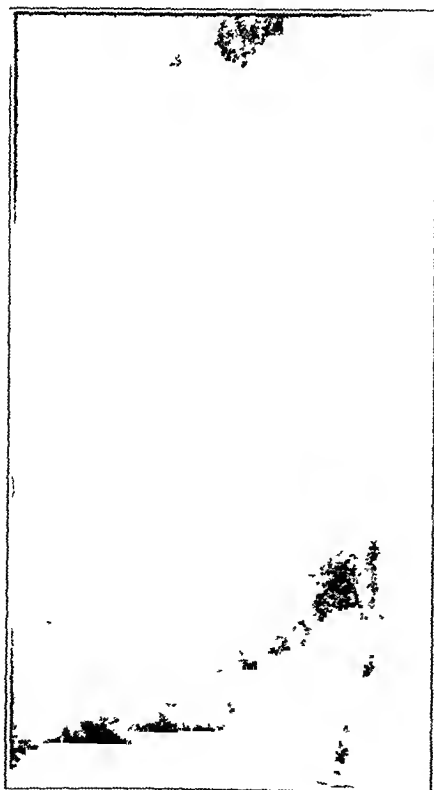


FIG. 1-A

August 22, 1939. Roentgenogram of spine at age of eleven years, showing flattened intervertebral discs, wedge-shaped vertebral bodies, cartilaginous nodules, and destruction of epiphyses.

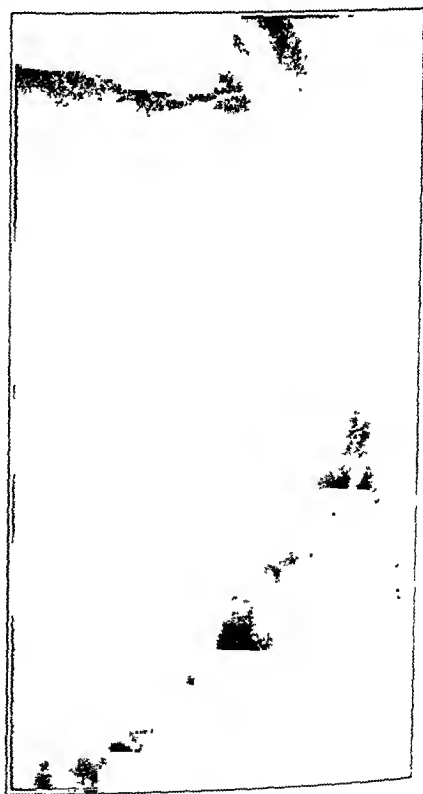


FIG. 1-B

May 2, 1940. Roentgenogram of same spine nine months later, following treatment. The kyphosis is less pronounced, and the destroyed portion of the epiphysis has been partly rebuilt by osteoid tissue.

NEURILEMMOMA OF BONE

A CASE REPORT

BY A. H. CONLEY, M.D., AND D. S. MILLER, M.D., CHICAGO, ILLINOIS

Primary nerve-sheath tumor of bone is an extremely rare condition. Peers described an intramedullary neurogenic sarcoma of the ulna and discussed the histogenesis of this tumor rather thoroughly. An amputation was done in his case.

Gross, Bailey, and Jacox were the first to describe a type of bone tumor which was benign in spite of the fact that it was locally invasive. De Santo and Burgess in 1940 reported a case of a nerve-sheath tumor which they considered benign. Their treatment was resection of the involved portion of the ulna, whereas the case reported by Gross, Bailey, and Jacox was treated by local excision.

The question of malignancy in this type of tumor is very important,—the treatment depending upon the microscopic diagnosis of the tumor.

This nerve-sheath tumor has in the past been called by many names such as neurofibroma, schwannoma, perineurial fibroblastoma, and peripheral neuroma. The term "neurilemmoma", used by Stout, is quite appropriate, and is used to describe the tumor in the following case, which, since the authors have had the opportunity to observe the patient for three years following operation for the removal of the tumor, seems of unusual interest.

Mrs. E. H., aged thirty-two, married, and the mother of one child, entered the Orthopaedic Clinic of the Cook County Hospital on March 16, 1939, with a history of pain along the distribution of the left sciatic nerve, numbness, and coldness of the entire left extremity. There was marked visible atrophy of the calf and thigh. The history of the condition dated back to 1928, when, two months after the birth of her child, pain developed in the left sciatic nerve and became progressively worse. Continual sedation was necessary, and, after two years, some regression of the pain was noted. There were periods of severe pain alternating with periods of paraesthesia of the left foot. During this interim a limp developed which became quite apparent, and was steppage in quality. She was unable to stand well on her toes or heel. Her past history was normal except for an oophorectomy eleven years previously. The report of the biopsy specimen of the ovary is not known.

A neurological examination made on admission revealed the following: There was visible atrophy of the left calf muscles and of the thigh; all movements of both lower extremities were possible; the Lasègue test was negative on the right, but positive on the left; the fabere test was negative bilaterally; the knee jerks were present bilaterally; and the ankle jerk was absent on the left. The plantar reflex was diminished on the left side; there was hypo-aesthesia to pain, touch, and vibration in the area of the left calf; the pupils reacted to light and accommodation; the cranial nerves revealed no pathology; and the fundi were normal. The impression was that of a low-sacral root lesion, probably at the fifth lumbar and first sacral on the left side, or a cauda equina lesion. Roentgenograms on this date revealed a delineated bone lesion the size of half a dollar, in the first sacral vertebra, left of the mid-line, which appeared cystic in nature.

A spinal puncture revealed a clear, colorless liquid; the manometric response was good; the spinal Wassermann was negative, the total protein being thirty-five milligrams per 100 cubic centimeters. Blood phosphorus was 3.33 per 100 cubic centimeters; calcium, 9.76; and phosphatase, 3.34. The blood Wassermann, urine, and total blood counts were normal.

At operation on March 23, 1939, the tumor was found to be encapsulated in the first sacral vertebra, lateral to the sacral canal which was definitely encroached upon. The first posterior sacral foramen was intact, and was not isolated during surgery. The tumor was reached through a linear incision two and one-half inches long directly over the first sacral vertebra. The skin, subcutaneous tissue, and the upper border of the

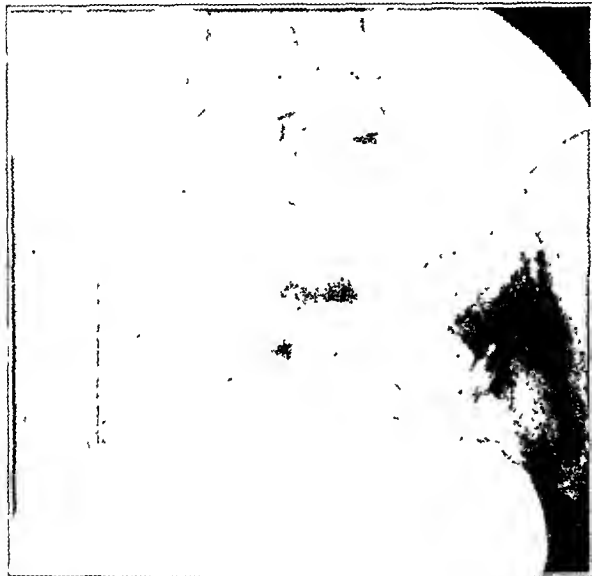


FIG. 3

May 23, 1940. The cyst wall is indistinguishable from the remainder of the bone. The cystic area has been filled in almost completely, except for a small area towards the mid-line.

multifidus were retracted, and the posterior wall of the tumor was seen as a thin cortical extension. This shell was removed by osteotome, and a thick grayish-yellow friable material was seen to extend through the entire cyst wall. The wall proper was fibrous in nature, and the medial extension of the cyst definitely encroached upon the sacral canal longitudinally for a distance of about two centimeters. There was no direct continuity between this and the sacral canal. The tumor was removed piecemeal by curettage, the wall was entirely curetted until raw bleeding bone was encountered; and the space left filled with blood, and no bone chips were replaced. The overlying soft structures were sutured, and the skin was closed without a drain.

The patient made an uneventful recovery. She was kept on a Bradford frame for three weeks and then wore a rigid lumbar corset.

The pathological report submitted by A. Ragins, M.D., was as follows:

"There are present multiple nerve-sheath cells in the characteristic palisade formation. A loose, connective-tissue stroma is the basis."

Following surgery the patient received roentgenotherapy weekly for ten weeks. Follow-up roentgenograms indicated a filling-in process in which the location of the original tumor had been almost entirely replaced by bone.

On September 15, 1941, two and one-half years after surgery, a neurological examination revealed the following: Atrophy was still present in the left calf and thigh; the knee jerks were present bilaterally, the right one more brisk than the left; both ankle jerks were present; deep tendon sensations were present; the left foot still indicated a mild talipes equinovarus deformity; and steppage gait was still present.

Briefly, the patient indicated improvement in the return of some of the sensation; the left ankle jerk had returned; the weakness was less; and the vibration sense had also returned. There was less atrophy of the calf and thigh. The conclusion was reached that there was a residual lesion of the fifth lumbar and first sacral roots.

Three years following surgery she was doing well, having had no recurrence of her pain although the original atrophy still remained. This last examination, made on March



FIG. 5

September 15, 1941. The roentgenogram indicates a rather diffuse filling-in of the previous defect. The small rarefied area with a mild trabeculation is still present.



FIG. 4

August 15, 1940. Sclerosis is slightly more advanced than in the previous roentgenogram

16, 1942, indicated that the patient had relief of pain, with the visible atrophy of the left calf and thigh less than that seen previously.

Figure 1 shows the tumor before surgery and Figures 2, 3, 4, and 5, the follow-up roentgenograms. Figure 6 demonstrates the characteristic appearance of this type of tumor, showing the palisading of nerve cells and the peculiar grouping.



FIG. 6

Photomicrograph ($\times 150$) shows palisading of the nuclei which is characteristic of neurilemmoma of bone. No indication of malignancy is seen.

CONCLUSIONS

A three-year study of a case of neurilemmoma, a rather rare type of bone tumor, indicates the definite progress from both roentgenographic and clinical viewpoints, which has been made in this patient.

The neurological examination of the patient indicated, in all probability, that this was a lesion in the region of the cauda equina. This must be differentiated from lumbosacral lesions, sciatic nerve neuritis, multiple nerve-sheath lesions, and the possibility of a ruptured intervertebral disc. The roentgenographic appearance of the tumor in this vicinity, and its encroachment upon the sacral canal excluded, anatomically, lesions of the above group. The relief of pain, in all probability, indirectly helped the patient's gait and the reduction of pressure in the canal may have directly relieved symptoms.

That there was no intrinsic cauda equina tumor may be inferred from the negative spinal tap which gave no evidence of irritation.

The authors concur with De Santo and Burgess that this is a benign tumor, and that excision, followed by roentgenotherapy, is the treatment of choice.

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later. Crutches were used, beginning two weeks after traction was removed.

Three years after injury, the patient had a very slight limp, and bony union was complete. However, as Figure 3 shows, aseptic necrosis of the femoral head, which is common in these cases, and degenerative arthritis have developed. The patient at the present time is able to flex the hip to 90 degrees, has lateral motion of 20 degrees, but no motion posteriorly. She walks with only a slight limp. No cane or other support is used in an active daily routine. There is no complaint of pain in any form.

It is the author's hope that this method of treatment may be given trial by others, and an accurate evaluation made.

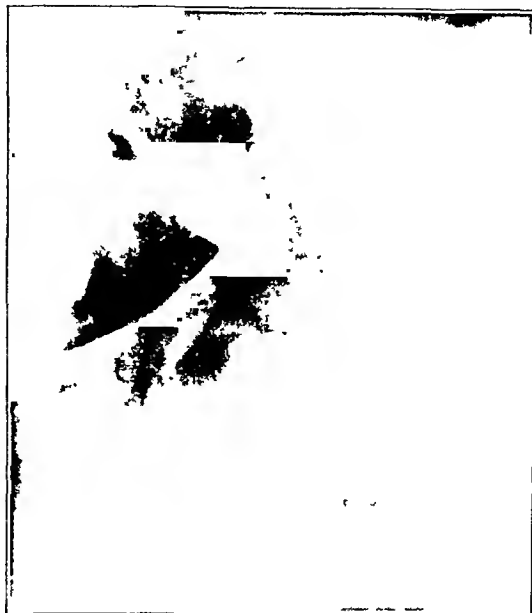


FIG. 2

June 9, 1938. Showing reduction obtained.

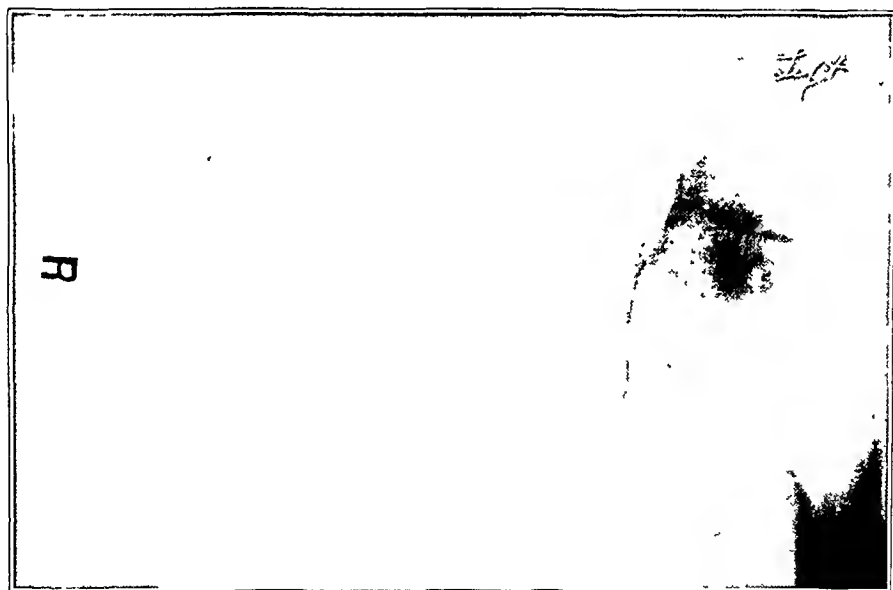


FIG. 3

February 24, 1941. Bony union is complete, but aseptic necrosis of the head of the femur and degenerative arthritis have developed.

AN APPLIANCE FOR THE EASIER AND MORE EFFICIENT APPLICATION OF SKELETAL TRACTION WITH THE STEINMANN PIN

BY JOHN LYFORD, III, M.D., AND H. ALVAN JONES, M.D.,
BALTIMORE, MARYLAND

From the Division of Orthopaedic Surgery, The Johns Hopkins Hospital, Baltimore

The application of skeletal traction with the Steinmann pin may be made easier and more satisfactory by employing a stirrup which is easily attached to the pin, is adjustable as to length and width, and is fitted

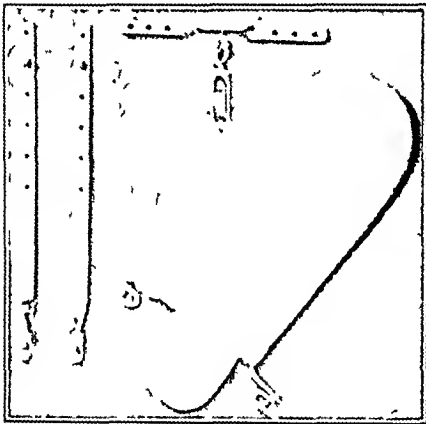


FIG. 1

The parts of the attachment, and the foot-plate

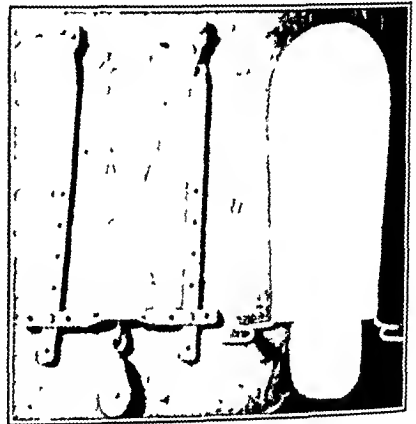


FIG. 2

The foot-plate and attachment assembled for use without the foot-plate

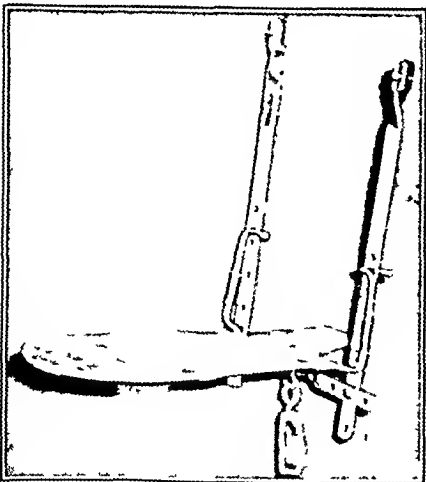


FIG. 3

The attachment assembled for use with the foot-plate.

with a readily removable foot-plate. The parts of such a stirrup are shown in Figures 1, 2, and 3. The stirrup forms a rectangle when attached to the Steinmann pin; hence a pulling force exerted on any point of the stirrup will be transmitted throughout all parts of the appliance directly to the Steinmann pin, and therefore to the bone. Thus permanently maintained rotary and angulating forces can be exerted on the bone, with only a single pulling force being necessary to bring about any given desired action on the bone.

The foot-plate can be used readily when the Steinmann pin is placed

through the os calcis or lower end of the tibia. In such instances it not only simplifies the problem of preventing foot-drop, but permits anterior

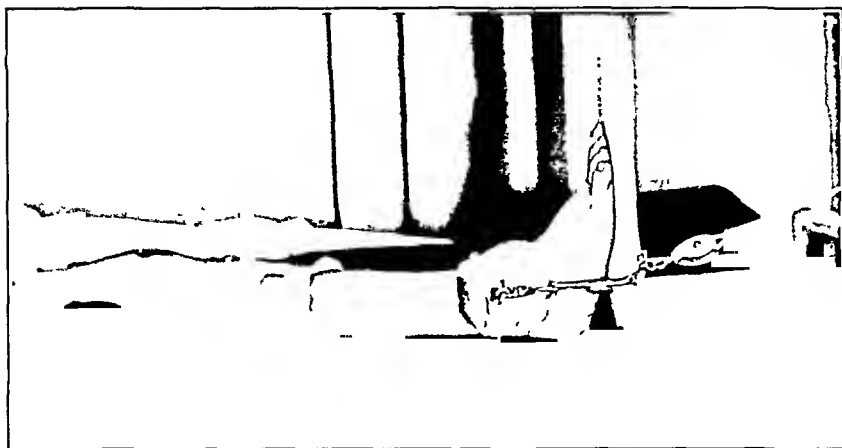


FIG. 4

The attachment in use with the Steinmann pin with simple extension traction.

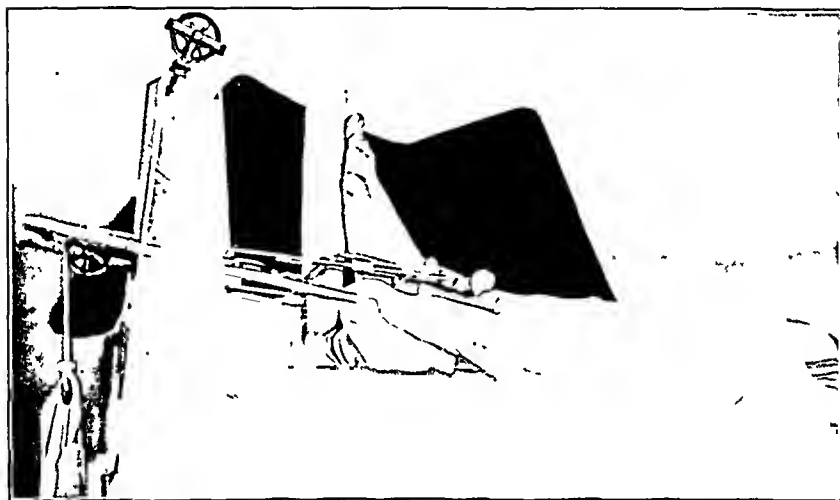


FIG. 5

An application of the attachment, showing the use of traction to obtain medial rotation of the distal fracture fragment.

and posterior angulating forces to be exerted on the bone (Figs. 4 and 5). These forces are transmitted to the bone through the fulcrum of the cross-bar which holds the foot-plate against the patient's foot, and prevents the plate slipping distally when the foot is plantar flexed (Figs. 3, 4, and 5).

Variations in the methods of applying traction to the stirrup, so as to obtain combinations of forces acting on the bone, are readily apparent. Figure 4 shows the appliance in use with simple extension traction. An application of traction to the stirrup to obtain medial or lateral rotation of the bone is shown in Figure 5.

The swivel pulley on the cross-bar facilitates the easy application of the Russell type of traction, without further modification of the stirrup, when this type of traction is used with a Steinmann pin passed through the os calcis or the distal end of the tibia.

A LIGHT FRACTURE FRAME: ITS USES AND CONSTRUCTION

BY E. W. CLEARY, M.D., BURLINGAME, CALIFORNIA

In 1935¹, the author described a frame which has since been used in the reduction of hundreds of fractures, and has proved helpful to a number of surgeons. Presentation of the improved frame seems worth while.

The frame is particularly adaptable for fractures of the tibia and fibula (Fig. 1), of the radius and ulna (Fig. 2), and of the os calcis. (Artificial limbs were used for illustration in the interest of clearer photography.) The appliance has been effective for reduction of fractures of the humerus and femur, for multiple fracture dislocations of the tarsals and metatarsals, and for reduction of shoulder dislocations of long standing. It has simplified the management of compound fractures. Surgeons treating fractures under conditions where adequate fracture equipment is not provided by an available hospital have found it especially helpful.

The dis-assembled frame (Fig. 3) can be put together in less than five minutes, and, when disassembled, may be packed into a small flat canvas bag. It weighs six and one-half pounds, the base weighing two and one-quarter pounds. If the occasion requires, it may be totally sterilized before assembly.

There is seldom occasion for retaining a frame for more than two hours to serve any one patient, but the equipment may be duplicated at

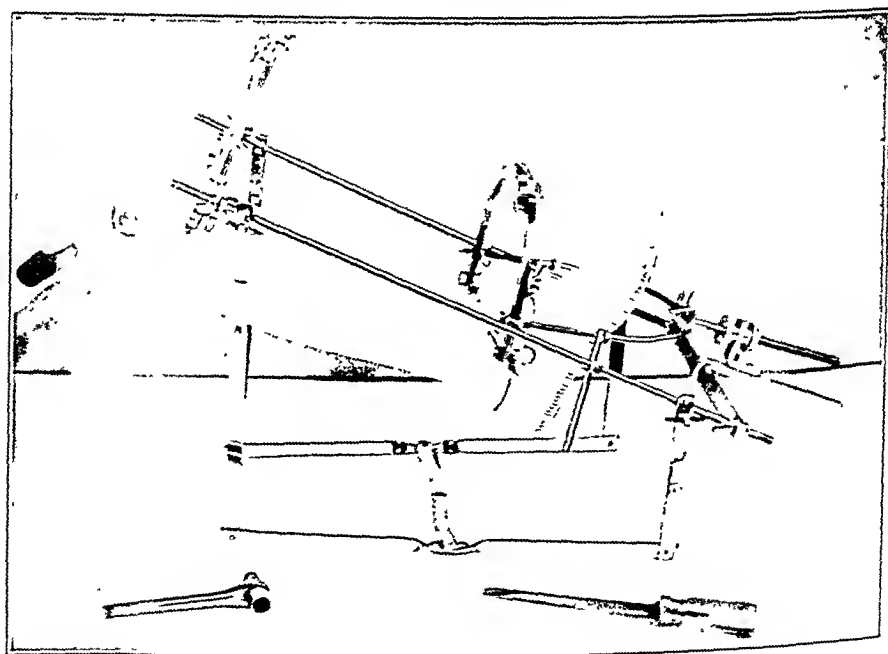


FIG. 1

Frame set up for traction on fractures of the leg bones.

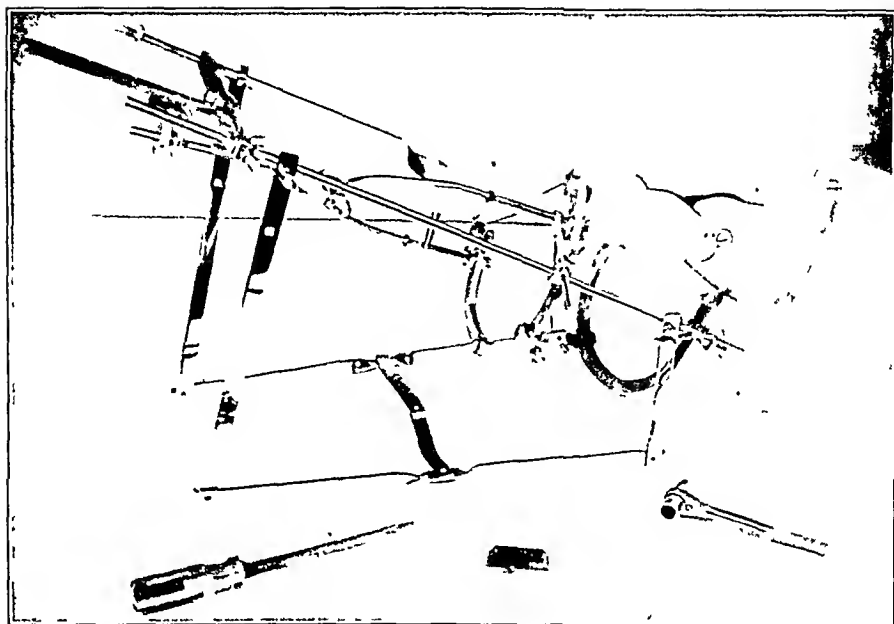


FIG. 2

Frame as used for forearm bone fractures.

such small cost and requires so little space for storage, that institutions which care for a large number of fractures, may provide a sufficient number of frames to meet any emergency. An assembly so light, adaptable, and easily fabricated may be especially useful during the national emergency.

For fractures of the tibia and fibula (Fig. 1), the frame base is raised proximally, so as to produce about 60 degrees of flexion in the knee. Note that in forearm fractures (Fig. 2), the base is reversed, so that the proximal bow of the frame is beneath the arm. When the frame has been put on a fractured limb and some traction has been applied, the limb and frame are lifted, the base (Fig. 3 *P*) is opened up, placed under the frame, and clamped to it.

The fractured limb is so accessible in this frame, that roentgenograms are readily taken, and casts or dressings are applied with relative facility.

After roentgenograms show reduction, a cast is applied, using standard quick-setting plaster. Clamps (Fig. 3 *T*) are tightened upon either end of each wire where it emerges from the cast. Wet plaster bandage is packed firmly between the clamp and cast, thus maintaining tension on the wire after it is released from the bow. Wires securely anchored in the cast *under tension* render correction by wedging the cast, if this is subsequently found to be necessary, safer and more effective. When the plaster has set (ten to fifteen minutes) the wires are cut outside the clamps and the frame is removed. If the frame is to remain on long without a cast, a sling support (not illustrated) is attached to the proximal bow and utilized to take the weight of the limb off the proximal wire.

In the reduction of old shoulder dislocations, the proximal wire is

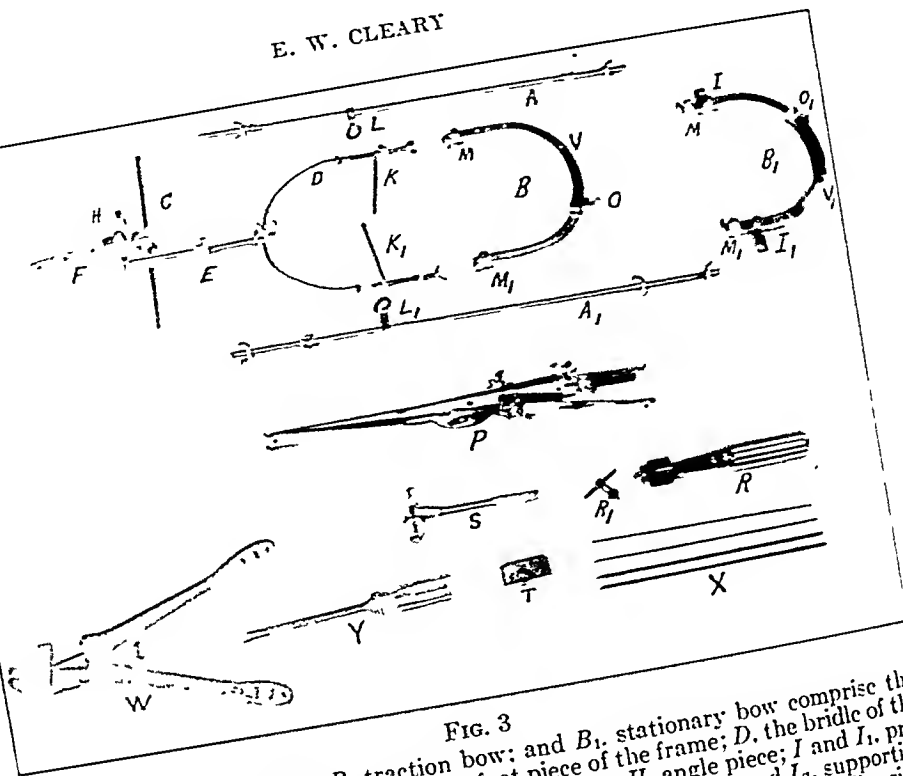


FIG. 3

A and A₁ frame rods, B, traction bow; and B₁, stationary bow comprise the proximal element of the frame. C is the foot piece of the frame; D, the bridge of the traction bow. E, traction screw; F, traction base bar; H, angle piece; I and I₁, projecting plates to receive A and A₁; K and K₁, supporting rods; L and L₁, supporting rod clamps; M and M₁, wire-locking discs; O and O₁, tension screws; P, collapsible frame base. R, wire-driving tool; S, chuck wrench; T, double-socket ratchet wrench; V and V₁, hinge screws; W, wire clamps; X, stainless-steel wires; Y, screw driver.

passed from front to back through the soft tissues beneath the acromion and the distal wire through the humerus above the condyles. In forearm fractures, the proximal wire traverses the ulna about an inch below the olecranon, the distal wire transfixes the radius only, about one inch above the wrist. This wire is inserted near the ventral margin and passes dorsally and ulnarward through the radius, emerging clear of the ulna on the dorsal surface.

A two-stage procedure is used on fractures in the upper third of the femoral shaft. First, two wires one-eighth of an inch thick and inserted at a considerable angle to each other, are driven from the lateral surface of the thigh well into, but not through, the upper femoral fragment. The proximal wire should pass through the trochanter and penetrate well into the femoral neck. The second wire is inserted in the same anteroposterior plane, about two inches distal to the first, and is driven toward the proximal wire, at an angle of approximately 60 degrees, when viewed anteriorly. A plaster spica includes both clamped wires, and terminates distally at about the level of the fracture. Wires are cut off outside the clamps, and the wire ends are incorporated in the cast. A middle wire tensed in the upper bow (Fig. 3 B₁) of the frame is placed transversely across the anterior surface of the cast near its distal extremity. The middle of this wire is incorporated in the cast. This completes the first stage.

As soon as the plaster has set sufficiently, another wire is driven transversely through the femoral condyles and is locked in the traction bow (Fig. 3 *B*). The frame and base are then set up as for fractures of the lower leg, traction is applied, and reduction is verified. The cast is then extended to the foot, the distal wire is clamped, and the frame is removed.

If available, a good fracture table is preferable for high fractures of the femur in adults.

For all transfixion traction, stainless-steel wires (chrome 18, nickel 8, carbon .08) in two sizes (one-sixteenth and one-eighth of an inch in diameter) are used. These are purchased by the pound and are cut in straight ten-inch lengths. The wires are pointed with a fine mill file or on a grinder. The author prefers a three-faceted trocar point. Points with facets twice as long as they are broad, readily cut through bone. He prefers to puncture the skin directly with both large and small wires. Additional transfixion wires are used whenever more than two seem to be needed. The wire-driving instrument (Fig. 3 *R*) is used in preference to any drill. This instrument has a hollow handle of duraluminum or monel metal, fluted and tapered. It is fitted to a Jacobs chuck. The chuck is drilled through, so that the larger-sized wire passes entirely through the instrument which is eight inches long. The use of this instrument leaves one hand of the operator free to grasp and steady the injured limb. Fibrous tissue does not wrap around the wires, and ring sequestration from friction burn does not occur when such an instrument is used. Some patience is required to drill the adult femoral shaft.

Abundant threads on the bars (*A* and *A*₁), the bridle (*D*), and the long traction screw (*E*), provide sufficient longitudinal adjustment of the frame to meet the requirements for any ordinary fracture (See Figure 3). A further range of adjustment is added by the choice of several holes in the traction base bar (*F*) for attachment of the angle piece (*H*). Time is saved by adjusting the span of the frame to the problem in hand before putting it on the fractured limb. Where distance between the proximal and distal wires is short, as in fractures of the os calcis *F* and *H* may be dispensed with, and the traction screw (*E*) may be operated through the center of the foot piece (*C*). Appropriate one-sided adjustment of the wing nuts on the bars (*A* and *A*₁) or the bridle (*D*), takes care of any tendency toward lateral angulation of a fracture. Free swiveling of the bow (*B*) with the traction screw (*E*) gives a complete range of rotation adjustments. Locking the knurled nuts on the traction screw holds any position of rotation. Sagging is prevented, and position in rotation is rendered doubly secure by gripping the supporting rods (*K* and *K*₁) to the frame bars (*A* and *A*₁), with clamps (*L* and *L*₁).

CONSTRUCTION

The frame is constructed of readily available materials, and any good mechanic with a few simple tools can make it. All rods and cold-rolled-steel bars are bent cold, using vise and bending irons. The tool-steel

locking discs must be brought to a white heat and chilled to secure a glass-hard temper. A lathe is necessary to turn out knurled nuts, but wing nuts may be substituted on the traction screw. Frames look better and are more easily cleaned if plated.

The collapsible base (*P*) is made of steel strap and is put together with round-headed rivets, so that it folds easily. Three holes in each long leg provide for height adjustment. Clamp hooks—square in cross-section—in square holes, open upward to receive the frame. Wire is cut with bolt cutter (*W*), or with Schollhorn-type pliers (not illustrated). The ratchet wrench (*S*), used to tighten locking discs (*M* and *M*₁) and tension screws (*O* and *O*₁), is stocked by auto-supply houses. Slots in the heads of all tap screws and bolts permit adjustment with screw driver as well as wrench.

All threads on adjustable parts are made reasonably loose. All holes, except those for locking discs and hinge bolts, are reamed out to an easy fit. The use of standard sizes of bolts, screws, wing-nuts, steel bars, and rods throughout, not only reduces cost of construction, but facilitates replacement of any part.

- 1 CLEARY, E. W.: A Light Inexpensive Frame for Transfixion-Wire Traction on Fracture of the Forearm and Leg. *J. Bone and Joint Surg.*, XVII '94, Apr. 1935.

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A SURVEY OF END RESULTS ON STABILIZATION OF THE PARALYTIC SHOULDER*†

REPORT OF THE RESEARCH COMMITTEE OF THE AMERICAN ORTHOPAEDIC ASSOCIATION

This report is based on a study of patients in twenty representative clinics throughout the country, conducted by the traveling fellow under the direction of your Research Committee. The study included only cases of infantile paralysis with some form of surgical stabilization of the shoulder, which had been done at least one year prior to examination. One hundred and forty-eight patients were examined, of whom 101 presented shoulder fusion (one patient had a bilateral fusion); forty-three, some form of muscle transplantation; two, the Nicola operation for subluxation of the shoulder; and one, a fascial sling operation, done by tying the two scapulae together.

I. ARTHRODESIS

Early in the course of the investigation, certain facts became apparent. We have felt that, in all of the 102 shoulders on which an arthrodesis had been attempted, some benefit had been received through increased stability, regardless of the position and whether or not fusion had occurred. However, less than 10 per cent. of the cases met all the criteria necessary to be classed as excellent. The results in a large majority of arthrodesed shoulders were below the possible optimum, because of some relatively minor defect in their management, the most frequent of which was some error in postoperative position. It would seem that too little attention was paid by the surgeon to the relative position of the humerus and the scapula. The majority of us have been placing the humerus in relation to the trunk and neglecting its relationship to the scapula. Too much emphasis has been placed, also, on securing abduction, but not enough on the degree of rotation of the arm.

Plan of Study

In studying the arthrodesed shoulder, an attempt was made to determine the actual position of fusion at the shoulder joint, the active range of motion of the arm in relation to the trunk, and the power in the muscle groups controlling the shoulder girdle. After this data was obtained on each case, an attempt was made to visualize some manner in which this individual patient might have been benefited by a change in treatment. In this way we have hoped to develop more accurate clinical information regarding the management of these cases than would be possible by a statistical study of averages.

The position of the arthrodesis was determined by maintaining the scapula in its normal anatomical position, and then measuring the humerus in relation to the axis of the body. Abduction was measured by determining the angle between the humerus and the sagittal plane of the body, while flexion was measured by determining the angle between the humerus and the frontal plane. Rotation was determined by flexing the elbow to a right angle and then, with the arm at the side, measuring the angle between the forearm and the sagittal plane of the body.

The average position of fusion in this series was found to be 40 degrees of abduction, 10 degrees of flexion, and 42 degrees of internal rotation. The average active rotation of the scapula in these cases was 70 degrees, which represents the difference between the completely abducted arm and the arm resting against the side of the body. This position is not the optimum for all cases, and it is felt that in general the position recommended for fusion will vary somewhat according to the age, sex, and remaining muscle power. With fair to good power in both the trapezius and the serratus anterior, we believe the position

* Read at the Annual Meeting of The American Orthopaedic Association, Baltimore, Maryland, June 6, 1942.

† This study has been sponsored by The National Foundation for Infantile Paralysis, Inc., New York, N. Y.

of fusion should be 45 to 55 degrees of abduction, 15 to 25 degrees of flexion, and 15 to 25 degrees of internal rotation.

Analysis of Position

It has been our observation in this study that a greater range of motion of the scapula develops in younger individuals than in the older patients. We have found that with the shoulder fused at 45 degrees of abduction, and with good muscles controlling the scapula, the arm will come to the side without winging, and can be actively abducted to about 90 degrees. A little more abduction will improve the functional result, but will not give so good a cosmetic effect. For this reason, in boys under twelve, the shoulder can be fused in 55 degrees of abduction. This may result in the arm hanging out from the side and a slight winging of the scapula. Girls object strenuously to this degree of abduction, in spite of the better function resulting from such a position.

Proper function of the fused shoulder in abduction depends on good power in the upper trapezius and in the upper two-thirds of the serratus anterior. The upper trapezius acts as an abductor by elevating the acromion, the entire shoulder girdle pivoting at the sternoclavicular joint. This will occur in the absence of power in the serratus anterior and several such cases were observed in this study.

Several facts were demonstrated when an arthrodesis was done without an active serratus. First, the trapezius can only abduct the arm about 45 degrees without the aid of the serratus anterior. Second, when the humerus is fused at 45 degrees or more from the scapula with an absent serratus anterior, the weight of the arm may rotate and depress the outer portion of the scapula to such a degree that the trapezius is overstretched and further weakened. It, therefore, appears that, in the absence of the serratus anterior, the angle of fusion in abduction should not be over 30 degrees in relation to the vertebral border of the scapula.

A few cases were noted with paralysis of all the muscles about the shoulder, except fair power in the trapezius, and yet, even in these, there was marked improvement following an arthrodesis. It has also been shown in this study that at least the appearance of the final shoulder can be improved by a properly performed arthrodesis, because the final shoulder which is usually carried higher, is aligned normally following fusion.

The proper position for function is, of course, the important one. In none of the clinics visited did there seem to be a constant relationship between the position in which the surgeon thought he was fusing the shoulder and the final position, or the position noted in the immediate postoperative roentgenogram. In one of the cases, the surgeon had not been satisfied with the amount of abduction present in the immediate postoperative roentgenogram, and four days later the plaster was wedged into 25 degrees more of abduction at the shoulder, giving an apparent improvement. A new roentgenogram, however, showed that only 5 degrees more of actual abduction in the joint had been obtained. This discrepancy between the actual abduction which is obtained, and that which the surgeon believes he has obtained, or intended to secure, is probably due largely to adduction contracture between the humerus and the scapula. In the majority of cases, the arm has been hanging at the side for a number of years before operation, and contractures usually have developed. As the result of recent interest in the Kenny treatment, it is likely that these contractures may be prevented in the future.

There has been found in this study a widespread opinion that arthrodesis of the shoulder should not be done in girls, because of a poor cosmetic result. With this we do not agree.

Abduction: True abduction can be measured at the operation by determining the angle between the vertebral border of the scapula and the humerus. After these bones have been adjusted to the desired position, the arm and scapula can be rotated as a unit to a position of 70 to 90 degrees of abduction of the arm in relation to the trunk, permitting a relaxation of the upper trapezius and serratus anterior. There is usually sufficient contracture of the adductors, so that the scapula will follow the arm. This relationship may not remain accurate, because of changes which are prone to occur in the angle of

abduction, due to rotation of the scapula within the plaster. This angle may decrease because of the pull of the adductors, or it may increase as the contracting adductors are stretched. Both conditions have been found in this study. It is our opinion that some form of internal fixation should be used between the scapula and the humerus. This may be obtained by the use of metal or bone which is inserted through the head of the humerus into the glenoid, or by fixation of the acromion to the humeral head or greater tuberosity.

Flexion: The amount of flexion in the fused shoulder is important from the standpoint of both function and cosmetic effect. Securing the correct amount of flexion is difficult. An attempt has been made to determine what would be the optimum position of flexion desirable in both the abducted and neutral positions of the scapula. If the amount of flexion in a fused shoulder is not more than 15 degrees, the weight of the arm will cause the scapula to lie flat against the chest wall, when only the trapezius is present. For this reason, flexion of the arm in a girl should be between 10 and 15 degrees. In a boy, flexion may be increased to 25 degrees for optimum functional use. Care must always be taken, however, to avoid excessive flexion, which will result in the winging of the scapula and the overstretching of the serratus anterior. Because of the normal variations in the curve of the chest wall, the degree of flexion is often an individual problem. In most patients, with the arm abducted 70 to 90 degrees, and forward about 35 to 40 degrees with the body planes, the resulting flexion is correct. A more accurate method would be to keep the scapula in the neutral position and bring the arm forward 15 to 25 degrees. It may be mentioned at this point that fusion without some flexion is always a most useless position for the arm.

Rotation: Proper rotation of the arm has not been sufficiently emphasized, judging from the cases observed in this study. It is felt, after checking the position of rotation at different angles of abduction, that this error is due largely to inaccuracy of descriptive terms. For example, what is believed to be a "slight external rotation" with the arm abducted to 90 degrees, is really internal rotation with the arm at the side. Rotation such that the "hand swings to the mouth" varies according to the degree of abduction. The "salute position", probably the most widely used term to describe the proper position for arthrodesing the shoulder, is a most misunderstood term.

Too great rotation and abduction at the shoulder joint has been the indication for numerous osteotomies to correct poor functional results. Too much external rotation of the arm is even worse than too much internal rotation. In only rare instances did the surgeon note the degree of rotation existing at the conclusion of the operation.

The most common complaint of the girls with fused shoulders, was the inability to fix their hair. With the arm in not more than 15 degrees of internal rotation, the hand can reach the top of the head without abducting more than 35 to 40 degrees. The ability to get the hand to the mouth was emphasized in many of the cases. It should be mentioned that girls are able to eat quite well with one hand, but it takes both hands to put up curls! A great deal more disability and impairment of function were observed following too much internal rotation.

Abduction of the humerus on the scapula of 45 to 50 degrees, with abduction of the arm from the body from 70 to 90 degrees, forward flexion from the scapula of 15 to 25 degrees, and a tilting upward of the flexed forearm 25 to 30 degrees above the horizontal constitutes the best position for fusion in the majority of cases. This position will result in about 25 degrees of internal rotation when the arm is brought down to the side. If the forearm is placed horizontal to the body when the arm is abducted, the resulting fusion will be 40 to 45 degrees of internal rotation. Greater internal rotation than this only results in a poor functional fusion.

In the presence of a weak elbow and hand, with the opposite extremity normal, the shoulder may be fused in greater internal rotation, but not over 45 degrees. On the other hand, too much external rotation causes difficulty in buttoning the vest and tucking in the shirt-tail. This difficulty is further aggravated whenever too much external rotation is combined with too much flexion.

Special Problems To Be Considered

The problem of arthrodesis of the shoulder in the presence of scoliosis requires special consideration. There were twenty-nine patients in a total of 148 examined, who gave a history of a preoperative scoliosis. At the time of the examination, the convexity of the curve in the upper thoracic region was toward the stronger shoulder in 66.7 per cent. of these cases. Only seven of the twenty-nine patients presented a severe curve, and in only one of these had the curve increased noticeably after arthrodesis. There was not sufficient evidence that the shoulder operation in itself had had any deleterious effect upon the scoliosis. In the twenty-nine cases, it was noted that the scoliosis limited considerably the range of motion in the scapula. In the presence of a severe curve, with the convexity toward the shoulder to be fused, care must be taken to avoid too much flexion of the arm. Otherwise, excessive winging of the scapula will result, and will accentuate the visible deformity.

We have tried to determine the age at which an arthrodesis is best done. The average age at which shoulder fusions were done in this study was twelve and one-half years. The youngest patient was six, and the oldest, thirty. Table I gives the ages at which a fusion was done and the results.

TABLE I
AGE OF 101 PATIENTS (102 SHOULDERS) AND RESULTS OF ARTHRODESIS

Age (Years)	No.	Non-Union	
		No.	Per Cent.
6	4	1	25
7	3	0	0
8	4	3	75
9	5	3	60
10	17	4	23.5
11	14	2	14.3
12	11	2	18.2
13	10	3	30
14	12	0	0
15	6	1	16.7
16	4	1	25
17 to 20	6	1	16.7
21 to 30	6	2	33.3
Total	102	23	22.5

This study did show that the range of motion is better in those patients in whom an arthrodesis had been done under the age of twelve, than in those of an older age group. It appears, also, that the danger of growth disturbance in operating on the shoulder in young children is more theoretical than real. Only one case of epiphyseal disturbance was seen following arthrodesis. This case was in a boy of eleven, who had previously had a trapezius transplant and a Nicola operation. An arthrodesis was done by the Steindler technique, with the addition of a Steinmann pin through the humeral head into the glenoid.

A bilateral arthrodesis was done in one case, because of two flail shoulders. We feel that if there had been sufficient muscle power for a transplantation on one side it might have been preferable. If it is necessary to fuse both shoulders, the position of fusion should allow the two hands to be brought together. If there is a difference

in muscle power in the two shoulders, the weaker one should be placed in more internal rotation. If the muscle power about the shoulders is essentially the same, the left shoulder in a right-handed person should have the greater degree of internal rotation, and *vice versa* for a left-handed individual.

In several instances, fusion of completely flail upper extremities gave satisfactory results. Four advantages for fusion under these circumstances were: ease of turning in bed; greater ease in getting into a coat; the ability to use the hand to steady a piece of paper while writing; and, lastly, an added feeling of stability or security in the shoulder. If only trapezius power was present, the patients preferred the fusion operation. In the presence of these flail or nearly flail extremities, a flexion contracture at the elbow was found to be of considerable benefit. One patient was seen in whom a flexorplasty of the elbow had been done. Although there had been no increase in the power of flexion, because the transplanted muscles were weak, the resulting flexion contracture at the elbow was of real value.

In weak or flail elbows, only slight abduction of the arm on the scapula is desirable, in order that the arm may come close to the side. In this type of disability, however, as much as 40 or 45 degrees of internal rotation was found desirable. It should also be mentioned that flexion power at the elbow frequently improved following stabilization of the shoulder.

Types of Operation

Regarding the type of operation, it appears that the technique employed in accomplishing the operation is not so important as the position and after-care. All of the operations for shoulder fusion gave good results, if the arm was placed in a satisfactory position for function, and if the postoperative care was adequate. The most popular operation throughout the country is that in which the acromion is thrust into a cleft in the head or neck region of the humerus, as described many years ago by Gill. Thirty-seven of the 102 arthrodeses in this series used this principle. In fifteen other patients, internal fixation was accomplished by using a bone graft, wires, nails, or screws. Your Committee feel that some type of joint fixation is desirable to lessen the danger resulting from movement between the humerus and the scapula within the plaster cast.

Postoperative Care

While it appears, at first glance, that there is a greater chance of non-union in attempting arthrodesis under the age of ten years, this study seems to show that this may be due to a shorter period of protection rather than to age.

The average time of immobilization in plaster, in all cases in which accurate records on this point were available, was only three and eight-tenths months. The shortest time in plaster was five weeks. Twenty-six of the patients were held in the casts two and one-half months or less. Of these, eleven, or 42 per cent., failed to obtain union. Forty-seven patients were in the casts three months or more. Of these, non-union developed in only eight, or 17 per cent. In four, or 67 per cent., of the six patients under ten years of age, who were kept in plaster less than two and one-half months, fusion failed. Of ten patients under ten years of age, who were kept in plaster three months or more, in only three, or 33 per cent., was there a failure of fusion. From the above, we would conclude that the time of immobilization may be more important than the age of the individual at the time of the operation.

In all patients examined, it appeared that, regardless of whether or not bony fusion occurred as demonstrated by roentgenograms, the joint became stabilized within five months after the operation. There may later prove to be exceptions to this statement as roentgenograms were not always available exactly five months after operation. However, we did find that, though the support was removed from the shoulder before the end of five months and union had not then occurred, the position of the shoulder remained unchanged after a five months' postoperative period. Therefore, we assumed that even if fusion had not occurred in the first five months, the fibrous ankylosis was then

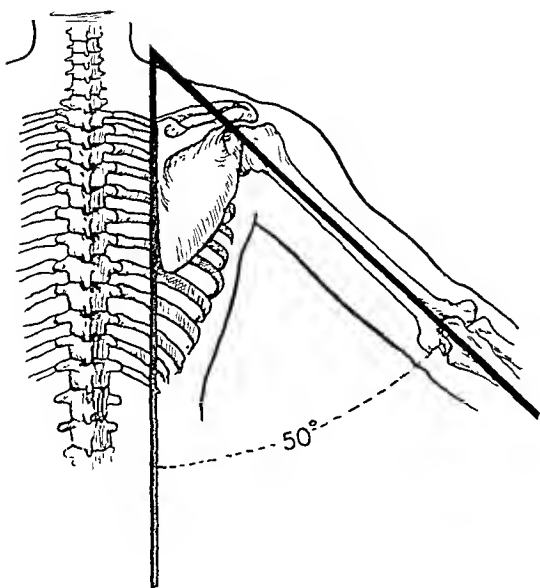


FIG. 1

Showing the recommended position of abduction of the skeleton from the back, with the scapula in the normal anatomical position, and the humerus abducted 50 degrees.

stationary. The exact time when bony union occurred appeared to vary considerably. One patient, who was immobilized for only three months, lost 15 degrees of abduction between the six weeks' and six months' postoperative periods, and, at the end of this time, non-union was still present. Two years later this patient presented solid bony fusion, without change in the position noted in the six months' postoperative roentgenogram. Another case was seen in which no evidence of fusion was visible in the roentgenogram eleven months postoperatively. Ten years later this patient presented solid bony union without any change in the abduction angle.

The use of an abduction splint for protection, after removal of the plaster, appears to be of questionable value. Whenever the plaster was left on for the required five months' period, a splint was found to be unnecessary. In view of this observation, some doubt might be cast on the use of an abduction splint for such excessively long periods as were encountered. In one case, a fifteen-year-old boy, who had had infantile paralysis when three years of age and who had worn a brace for ten out of the twelve years since the onset of the disease, was still wearing it twenty-two months after operation, although he presented a solid fusion. Another patient was found wearing a brace nineteen months after operation, although the roentgenogram twelve months previously had shown bony union.

There has been the impression that firm fibrous union of the shoulder is as satisfactory as bony union. This opinion needs qualification. In most of the cases of non-union, very little actual abduction was present between the scapula and the humerus, and this resulted in a poor range of scapular motion. The trace of motion in the shoulder joint proper that was found in these patients, frequently caused pain or a sense of fatigue. Therefore, we feel that a firm fibrous union is rarely as satisfactory as a solid bony union.

II. MUSCLE TRANSPLANTATIONS

Forty-three patients had sixty-two operations. Though there were subsequent operations on a number of shoulders, no bilateral transplantations were found. Of the transplantations, a total number of twenty-nine consisted of transference of the

sufficient to maintain permanently this position of the joint. This is a valuable fact, if time substantiates this impression, because it means that proper plaster support for the arthrodesed shoulder is usually unnecessary for more than five months after operation. Our records show that the shoulder should be kept in plaster for a minimum of three months after the fusion operation. At the end of this time, if a roentgenogram does not show the beginning of bony fusion, a new plaster should be applied for an additional two months' period.

Another fact that has been revealed by this study—and this, without exception—is that, when we have roentgenographic evidence of the beginning of bony union, no further change in the angle of abduction will develop. Many of the cases lost between 10 and 20 degrees of the original abduction in the first five months, and then remained practically sta-

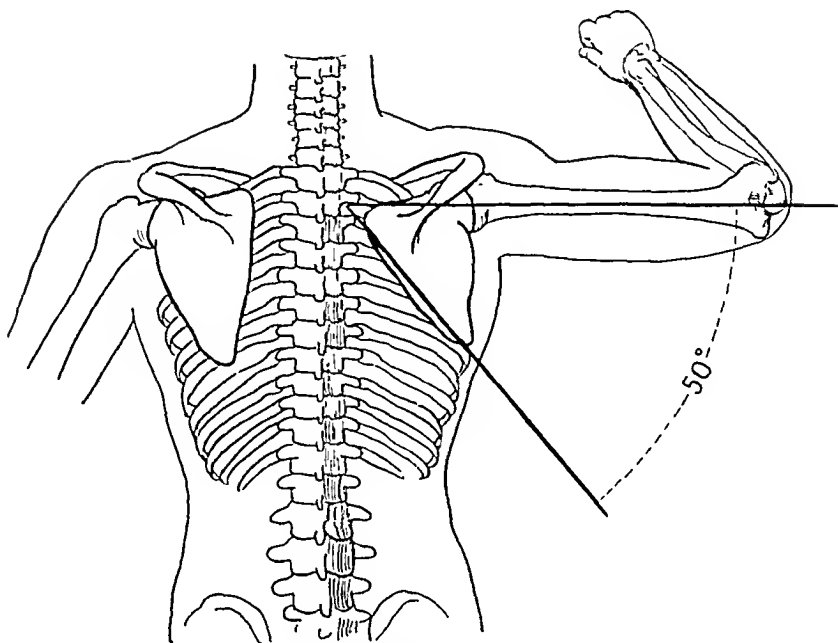


FIG. 2

View from the back showing position of postoperative fixation; and relation of the scapula to the humerus, and of the arm to the trunk.

short head of the biceps and the long head of the triceps to the acromion, or some modification of this technique as described by Ober. Some of these transplantations were combined with other operations to meet particular indications. There were thirteen Nicola operations done in conjunction with some other transplantations.

In considering the total forty-three patients with transplantations, sixteen showed no improvement. Eighteen presented only slight improvement, consisting of an increased stability with little or no increase in the range of motion or strength in the joint. In eight of the total number, it was found that the muscle transplantation gave a better result than could have been obtained by any other type of surgery. The operations performed in these patients were equally divided between the Ober and the Mayer types of operation. In *none* of these eight patients was the deltoid *completely* paralyzed. In the Ober operation, contraction of the transplanted biceps in the absence of a deltoid seemed to lock the humerus to the scapula by a direct, upward pull, and the patient was unable to initiate abduction at the scapulohumeral joint.

In the Mayer procedure, the transplanted trapezius pulled upon its fascial prolongation, which often became attached to the acromion by adhesions, holding the humerus abducted. This fascial strip, therefore, acted only as a check ligament when the scapula was actively rotated upward.

An example of the action of the transplanted biceps and triceps was seen in a somewhat exaggerated form in one case. The strong pectoralis major pulled the head of the humerus down against the rim of the glenoid, after which the hypertrophied transplanted triceps locked it in this position. Abduction to 80 degrees occurred by rotation of the scapula, giving an unusual degree of motion, but when the humerus was passively held in the glenoid, the patient could not abduct the arm.

Three patients were seen in whom the strong posterior deltoid was shifted forward to the acromion and outer end of the clavicle, to act as an abductor. One of these attained an excellent result, while the others had only fair results. This procedure would appear to be an excellent one in selected cases. Even though the deltoid may be some-

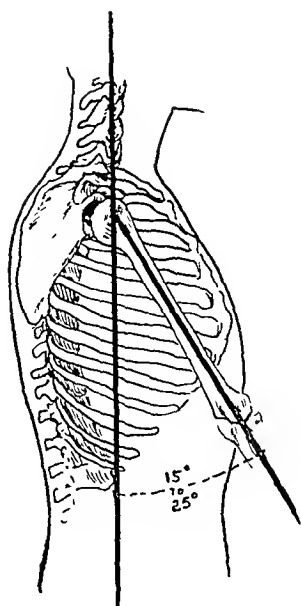


FIG. 3

Showing recommended flexion from the side, with scapula in the normal anatomical position.

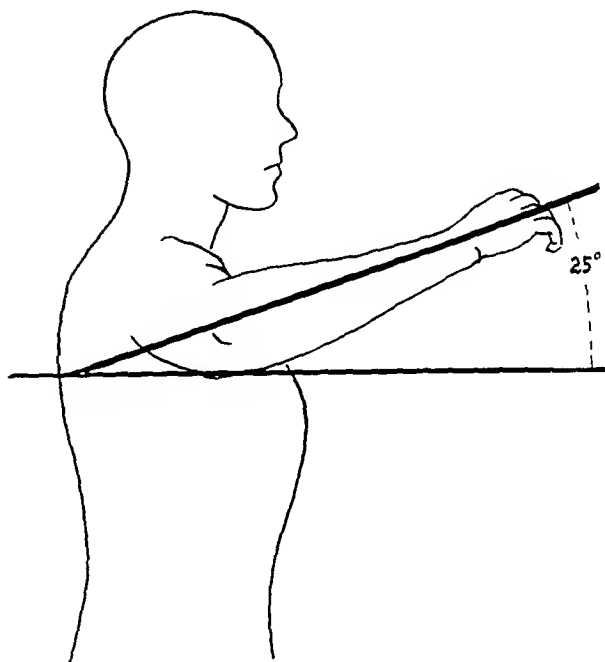


FIG. 4

Showing the postoperative position from the side, and illustrating flexion and rotation.

what weakened following operation, it is in a much better position for the abduction movement.

The time of postoperative support following operations for muscle transplantations varied a great deal, irrespective of the clinic. Some patients discarded all support after six weeks, and others kept the abduction splint on for years. One twelve-year-old child had worn a brace four years before operation, and was still wearing it seven and one-half years after a muscle transplantation, but apparently without benefit. Another child wore a brace eight years after operation.

In some of the cases, there was a loss of power in the biceps and triceps after transferring them to the acromion. This was so marked in several instances, that the ability to flex the elbow against gravity was lost, although, before surgery, there had been a satisfactory degree of muscle power in the biceps. This was also noted in a few cases following trapezius transplantations.

The statement that, if a transplant fails, one can always do an arthrodesis, must be questioned. Eighteen patients had a total of twenty-seven transplant operations before arthrodesis of the shoulder. There was a demonstrable lack of freedom of motion in the scapula in these patients, compared with those in whom the arthrodesis was the primary operation.

Two cases were seen in which the Nicola operation had been done to correct subluxation in paralytic shoulders. There was slight improvement in one, but in the other there was not sufficient improvement to justify the operation. We question the advisability of using this procedure for correcting a subluxation which occurs as the result of infantile paralysis.

One case was seen in which an attempt was made to stabilize both shoulders by tying the scapulae together with a strip of fascia without, however, any demonstrable benefit.

CONCLUSIONS

1. *Arthrodeses of the Shoulder*

This survey would indicate that an arthrodesis of the shoulder joint is the operation of choice in all cases of infantile paralysis with complete paralysis of the deltoid. An

upper trapezius with only fair power was found to be the only muscle which *must* be present. If both trapezius and serratus anterior are present, a satisfactory range of motion and power should be obtained. The operation should result in improved function of the upper extremity with little loss of cosmetic effect.

The optimum position of fusion was found in most cases to be 45 to 55 degrees of abduction, 15 to 25 degrees of flexion, and 15 to 25 degrees of internal rotation. A correct degree of rotation was found to be more important from a functional standpoint than the degree of abduction (Figs. 1, 2, 3, and 4).

Postoperative fixation in plaster from a minimum of three months to a maximum of five months appeared sufficient. A fusion operation can be done any time after the age of six years. While in the younger patients, a better range of motion developed, the percentage of failure of fusion was found to be consistently higher.

2. *Muscle Transplantations at the Shoulder*

The satisfactory muscle transplantations were found only in those cases possessing fair power in the deltoid preoperatively.

JOSEPH S. BARR, M.D., *Chairman*

JOSEPH A. FREIBERG, M.D.

PAUL C. COLONNA, M.D.

PAUL A. PEMBERTON, M.D., *Research Fellow*

News Notes

Dr. Arthur Steindler, Professor of Orthopaedic Surgery, State University of Iowa, has been honored by the National University of Mexico by being made Professor of Orthopaedic Surgery. This nomination makes him an extramural member of the medical faculty of this University. He has also been made an honorary member of several medical societies in Mexico.

Dr. Dudley M. Stewart announces the removal of his office to the Professional Building, 1838 Parkwood Avenue, Toledo, Ohio.

The annual meeting of the United States Chapter of the **International College of Surgeons** is to be held in Denver, Colorado, July 15 to 18.

The Fourth Annual Session of **The American Association for the Surgery of Trauma** was held in Boston on June 4, 5, and 6 under the presidency of Dr. Henry C. Marble. An excellent program was presented. The president for the coming year is Dr. Charles S. Venable of San Antonio, Texas.

The **Biological Photographic Association** will hold its Twelfth Annual Convention in New York City, September 10, 11, and 12. Information may be obtained from the Chairman, Mr. Joseph Haulenbeek, Rockefeller Institute for Medical Research, New York.

The Second Annual Meeting of the **New England Society of Bone and Joint Surgery** was held at the Hartford Golf Club, Hartford, Connecticut, on June 19. The newly elected officers are: President, Dr. Allan Woodcock, Bangor, Maine; Vice-President, Dr. G. E. Haggart, Boston; and Secretary-Treasurer, Dr. Gordon M. Morrison, Boston. Dr. John H. Sweet, Jr., of Hartford, was made an Honorary Member. The next Annual Meeting is scheduled to be held in May 1943, in Bangor.

Annals of Surgery is now available in Spanish. Beginning with the issue of June 1942, that journal is to be published simultaneously in Philadelphia, by J. B. Lippincott Company, and in Buenos Aires, by the Guillermo Kraft Company.

It is significant that this excellent journal of surgery, established in 1885 by Dr. Lewis Stephen Pilcher, who was Editor for fifty years, should take this important step. The fact that there is a call for a Spanish translation of the *Annals* is indicative of the growing interest of the surgeons of the Americas in each other's problems. The medical profession in this country has become increasingly aware of its obligations and responsibilities in South America. No better symbolic demonstration can be given of its sincere willingness to develop permanent intellectual fraternization between the surgeons of the two continents.

THE BRITISH ORTHOPAEDIC ASSOCIATION

The British Orthopaedic Association held its Spring Meeting in Liverpool, May 29 and 30. The principal subjects of discussion were as follows:

Delayed Union of Fractures in the Lower Limb.

Mr. George Perkins (Ministry of Pensions).

Mr. R. Watson-Jones and Sq.-Ldr. W. D. Coltart (R.A.F.).

Mr. B. H. Burns (E.M.S.).

Major W. White (R.C.A.M.C.).

Dr. E. Harlan Wilson (American Hospital in Britain).

Methods of Amputation in the Lower Limb: a Comparison of Canadian and British Experience.

Dr. A. B. LeMesurier (Toronto).

Dr. R. D. L. Kelham (Ministry of Pensions, Rochampton).

Other papers presented were:

Transtrochanteric Fracture of the Femur.

Mr. N. L. Capener.

Rate of Regeneration of Peripheral Nerves.

Prof. H. J. Seddon.

Fractures of the Femur.

Mr. W. S. Diggle.

Air Arthrography in Lesions of the Semilunar Cartilages.

Mr. C. H. Cullen and Dr. G. Q. Chance.

The afternoon of the first day was devoted to a visit to the Rehabilitation Centre, Hoylake, by courtesy of the Air Ministry.

The Association Dinner was held at the Adelphi Hotel on the evening of May 29.

THE AMERICAN ORTHOPAEDIC ASSOCIATION

The Fifty-Sixth Annual Session of The American Orthopaedic Association, under the Presidency of Dr. George E. Bennett, was held in Baltimore, on June 3, 4, 5, and 6, 1942. The headquarters were at the Lord Baltimore Hotel.

On the first day, Wednesday, a clinical program was presented in Hurd Memorial Hall, Johns Hopkins Hospital, by the following surgeons: Dr. George O. Eaton, Dr. John Lyford, III, Dr. Moses Gellman, Dr. Harold R. Bohlman, Dr. I. William Nachlas, Dr. Winthrop M. Phelps, Dr. Edwin D. Weinberg, and Dr. Allen F. Voshell.

At noon, Dr. Kellogg Speed read a paper on "Post-Metastatic Survival of Osteogenic Sarcoma", with discussion opened by Dr. J. Albert Key.

After luncheon at the Great Hall, Welch Library, the Annual Golf Tournament was held at the Elkridge Club, followed by the Golf Dinner. During the afternoon, Dr. Winthrop M. Phelps held Open House at the Children's Rehabilitation Institute. The Curative Workshop at the Johns Hopkins Hospital and the Physiotherapy Department at the Children's Hospital School were also visited by many of the members and guests.

Beginning with Thursday morning, the following program was presented:

THURSDAY, JUNE 4

Morning Session

Tangential Fracture of the Patella.

Dr. J. E. Milgram, Brooklyn, New York.

Discussion: Dr. Samuel Kleinberg, New York, N. Y.

Modified Operation for Opponens Paralysis.

Dr. T. Campbell Thompson, New York, N. Y.

Discussion: Dr. Leo Mayer, New York, N. Y.

Dr. Alan DeForest Smith, New York, N. Y.

Dr. J. Albert Key, St. Louis, Missouri.

Dr. A. Bruce Gill, Philadelphia, Pennsylvania.

Dr. T. Campbell Thompson, New York, N. Y.

Spondylolisthesis.

Dr. Henry W. Meyerding, Rochester, Minnesota.

Discussion: Dr. R. I. Harris, Toronto, Ontario.

Dr. Edwin W. Ryerson, Chicago, Illinois.

Dr. Elmer P. Weigel, Plainfield, New Jersey.
 Dr. Samuel Kleinberg, New York, N. Y.
 Dr. J. Albert Key, St. Louis, Missouri.
 Dr. Henry W. Meyerding, Rochester, Minnesota.

The Healing of Fractures.

Dr. Robert W. Johnson, Jr., and (by invitation) Dr. Marshall R. Urist, Baltimore, Maryland.

Discussion: Dr. William E. Gallie, Toronto, Ontario.
 Dr. Robert W. Johnson, Jr., Baltimore, Maryland.
 Dr. George E. Bennett, Baltimore, Maryland.

Metal Internal Fixation in Lumbosacral Fusion.

Dr. Philip D. Wilson, New York, N. Y.

Discussion: Dr. Alan DeForest Smith, New York, N. Y.
 Dr. Mather Cleveland, New York, N. Y.
 Dr. Philip D. Wilson, New York, N. Y.

Malignant Vascular Tumors of Bone.

Dr. Atha Thomas, Denver, Colorado.

Afternoon Session

Management of Wounds of the Extremities in Modern Warfare.

Col. J. A. MacFarlane, R.C.A.M.C., Surgical Consultant to the Canadian Active Service Force. (By invitation.)

Orthopaedic Surgery in the Naval Medical Service.

Capt. F. R. Hook, U.S.N., Washington, D. C. (By invitation.)

Immersion Foot.

Lt. Comdr. D. R. Webster, Halifax, Nova Scotia. (By invitation.)

Pin Fixation in War Fractures.

Dr. Wallace H. Cole, St. Paul, Minnesota.

Report of the Combined Military Committees of The American Orthopaedic Association and The American Academy of Orthopaedic Surgeons.

Dr. Guy W. Leadbetter, Chairman, Washington, D. C.

Chemotherapy in the Treatment of Wounds.

Dr. Perrin H. Long, Baltimore, Maryland. (By invitation.)

FRIDAY, JUNE 5

Morning Session

End Results of Treatment of Poliomyelitis in Baltimore.

Dr. Raymond E. Lenhard, Baltimore, Maryland. (By invitation.)

End Results of Treatment of Poliomyelitis in Detroit.

Dr. Charles W. Peabody, Detroit, Michigan.

End Results of Operative Treatment of Poliomyelitis.

Dr. Isadore Zadek, New York, N. Y.

Departures from the Principle of Absolute Fixation in the Treatment of Anterior Poliomyelitis.

Dr. Arthur Steindler, Iowa City, Iowa.

Spasticity of Muscles in Anterior Poliomyelitis.

Dr. R. Plato Schwartz, Rochester, New York.

Discussion of the five foregoing papers:

Dr. Wallace H. Cole, St. Paul, Minnesota.
 Dr. Frank R. Ober, Boston, Massachusetts.
 Dr. H. R. McCarroll, St. Louis, Missouri.
 Dr. Charles LeRoy Lowman, Los Angeles, California.
 Dr. A. Bruce Gill, Philadelphia, Pennsylvania.

Indications for the Intravenous Use of Amino Acid Mixtures in Surgery.

Dr. Lee E. Farr, Wilmington, Delaware. (By invitation.)

Discussion: Dr. L. Emmett Holt, Jr., Baltimore, Maryland. (By invitation.)

Dr. A. R. Shands, Jr., Wilmington, Delaware.

Dr. Lee E. Farr, Wilmington, Delaware.

Method of Measuring Strength of Trunk Muscles.

Dr. Leo Mayer and (by invitation) Dr. Benjamin B. Greenberg, New York, N. Y.

Discussion: Dr. Arthur Steindler, Iowa City, Iowa.

Dr. Leo Mayer, New York, N. Y.

Arthrodesis of Wrist Joint.

Dr. LeRoy C. Abbott, Dr. Frederic C. Bost, and (by invitation) Dr. John B. deC. Saunders, San Francisco, California.

Discussion: Dr. J. Albert Key, St. Louis, Missouri.

Dr. Compton Riely, Baltimore, Maryland.

Dr. LeRoy C. Abbott, San Francisco, California.

Mechanics of the Arch of the Foot.

Dr. Paul W. Lapidus, New York, N. Y. (By invitation.)

Discussion: Dr. R. Plato Schwartz, Rochester, New York.

Dr. Isadore Zadek, New York, N. Y.

Dr. Leo Mayer, New York, N. Y.

Dr. Paul W. Lapidus, New York, N. Y.

Afternoon Session

President's Address.

Dr. George E. Bennett, Baltimore, Maryland.

Compound Fractures.

Dr. Arthur G. Davis, Erie, Pennsylvania.

Discussion: Dr. H. Earle Conwell, Birmingham, Alabama.

Dr. Leo Mayer, New York, N. Y.

Dr. R. I. Harris, Toronto, Ontario.

Dr. Arthur G. Davis, Erie, Pennsylvania.

Fractures of the Odontoid Process.

Dr. W. E. Gallie, Toronto, Ontario.

Discussion: Dr. Frederick A. Jostes (read by the Secretary).

Dr. William G. Turner, Montreal, Quebec.

Dr. Fred H. Albee, New York, N. Y.

Dr. Paul B. Steele, Pittsburgh, Pennsylvania.

Dr. W. E. Gallie, Toronto, Ontario.

End Results of Bloodless Reduction of Congenital Dislocation of the Hip.

Dr. A. Bruce Gill, Philadelphia, Pennsylvania.

Discussion: Dr. Clarence H. Heyman, Cleveland, Ohio.

Spontaneous Fracture of the Neck of the Femur Following Radiation Treatment for Pelvic Malignancy.

Dr. Carl E. Badgley and (by invitation) Dr. Harold Bowman, Ann Arbor, Michigan.

Discussion: Dr. W. E. Gallie, Toronto, Ontario.

Dr. Carl E. Badgley, Ann Arbor, Michigan.

Osteomyelitis and Its Treatment by Sulfonamide Drugs.

Dr. John C. Wilson and Dr. Francis M. McKeever, Los Angeles, California.

Discussion: Dr. D. E. Roberston, Toronto, Ontario.

Dr. Benjamin P. Farrell, New York, N. Y.

Dr. I. William Nachlas, Baltimore, Maryland.

SATURDAY, JUNE 6

Morning Session

Etiology of Aseptic Necrosis of Head of Femur Following Fractures.

Dr. Edward L. Compere, Chicago, Illinois.

Discussion: Dr. J. Albert Key, St. Louis, Missouri.

Dr. Edward L. Compere, Chicago, Illinois.

The Use of Steel Wires for the Retention of Bone Fragments.

Dr. A. W. Farmer, Toronto, Ontario.

Discussion: Dr. J. S. Speed, Memphis, Tennessee.

Dr. R. I. Harris, Toronto, Ontario.

Repair of Complete Acromioclavicular Dislocation with the Aponeurosis of the Short Head of the Biceps.

Dr. Luthero Vargas, Rio de Janeiro, Brazil. (By invitation.)

Discussion: Dr. Carl E. Badgley, Ann Arbor, Michigan.

Dr. Luthero Vargas, Rio de Janeiro, Brazil.

Local Anaesthesia in Spine Surgery.

Dr. Joseph A. Freiberg, Cincinnati, Ohio.

Discussion: Dr. J. H. Kite, Decatur, Georgia.

Dr. Henry W. Meyerding, Rochester, Minnesota.

Dr. Joseph A. Freiberg, Cincinnati, Ohio.

A Survey of End Results on Stabilization of the Paralytic Shoulder. Report of the Research Committee of The American Orthopaedic Association.
Read by Dr. Paul C. Colonna, Oklahoma City, Oklahoma.

Discussion: Dr. A. Bruce Gill, Philadelphia, Pennsylvania.

Refrigeration Anaesthesia for War Injuries of the Extremities.

Dr. Frederick M. Allan (by invitation) and Dr. Lyman W. Crossman (by invitation), New York, N. Y.

Discussion: Dr. Philip D. Wilson, New York, N. Y.

Dr. Lyman W. Crossman, New York, N. Y.

Executive Sessions were held at noon on Thursday and on Saturday.

Dr. and Mrs. Bennett entertained the members and guests at a reception and buffet dinner at the Elkridge Club on Thursday, and the Annual Dinner of the Association was held at the Lord Baltimore Hotel, Friday evening.

Dr. Frank R. Ober, Boston, Massachusetts, is President of the Association for the year 1942-1943.

At the Executive Session, the following new officers and members of committees were elected:

Officers

President-Elect: Dr. A. Bruce Gill, Philadelphia, Pennsylvania.

Vice-President: Dr. John Dunlop, Pasadena, California.

Secretary: Dr. Charles W. Peabody, Detroit, Michigan.

Treasurer: Dr. Frank D. Dickson, Kansas City, Missouri.

Committee members and delegates

Membership Committee: Dr. H. Earle Conwell, Birmingham, Alabama.

Program Committee: Dr. Lloyd T. Brown, Boston, Massachusetts.

Delegate to the American College of Surgeons: Dr. Edwin W. Ryerson, Chicago, Illinois.

Representatives on the American Board of Orthopaedic Surgery:

Dr. LeRoy C. Abbott, San Francisco, California.

Dr. Harold H. Hitchcock, Oakland, California.

At this Meeting, the following were received into membership:

Active members

Dr. William T. Green, Boston, Massachusetts.
 Dr. Keene O. Haldeman, San Francisco, California.
 Dr. Jacob Kulowski, St. Joseph, Missouri.
 Dr. Joseph B. L'Episcopo, Brooklyn, New York.
 Dr. Henry R. McCarroll, St. Louis, Missouri.
 Dr. Robert G. Packard, Denver, Colorado.
 Col. Jesse I. Sloat, Atlanta, Georgia.

Corresponding members

Mr. R. Watson-Jones, Liverpool, England.
 Mr. H. J. Seddon, Oxford, England.

Due to existing conditions, the Meeting, originally scheduled to include sessions at Virginia Beach, was held entirely at Baltimore. That the necessary changes were made, and the plans for the Meeting so successfully carried out, was due in large measure to the efforts of the President, Dr. Bennett, and to the local committee of which Dr. Robert W. Johnson, Jr., was Chairman. Dr. I. William Nachlas was in charge of entertainment, and Dr. Allen F. Voshell, of the golf tournament and dinner. Dr. R. I. Harris, of Toronto, was Chairman of the Program Committee.

ACKNOWLEDGMENTS

The Journal wishes to acknowledge the receipt of the following publications sent to the Editorial Department:

- Americana Clinica (New York, N. Y.), III, Nos. 4 and 5, 1942.
 Anais Paulistas de Medicina e Cirurgia (São Paulo, Brasil), XLII, Indice, 1941; XLIII, Nos. 1, 2, and 3, 1942.
 Medical Statistics Bulletin No. 1. Analysis of Reports of Physical Examination. Summary of Data from 19,923 Reports of Physical Examination. Washington, D. C., National Headquarters, Selective Service System. November 10, 1941.
 Boletim do Sanatorio São Lucas (São Paulo, Brasil), III, Nos. 7, 8, and 9, 1942.
 Boletín del Colegio Médico de la Habana (Cuba), V, Nos. 4 and 5, 1942.
 Bulletin of the Hospital for Joint Diseases (New York, N. Y.), III, No. 2, 1942.
 Cleveland Clinic Quarterly, IX, No. 2, 1942.
 Georgia Warm Springs Foundation. Annual Report for the Fiscal Year Ended September 30, 1941.
 Harper Hospital Bulletin (Detroit, Michigan), I, Nos. 6 and 8, 1942.
 Médica (Matanzas, Cuba), I, Núms. 2 and 3, 1942.
 The Merck Institute for Therapeutic Research (Rahway, New Jersey), 1942.
 University of Pennsylvania Bulletin. Graduate School of Medicine. The Medico-Chirurgical College. Announcement for Session 1942-1943 (XLII, No. 33). Philadelphia, 1942.
 La Prensa Médica Mexicana (México, D. F.), VII, Núms. 3, 4, and 5, 1942.
 Proceedings of the Staff Meetings of the Mayo Clinic (Rochester, Minnesota), XVII, Nos. 15, 16, 17, and 18, 1942.
 Respirators. Locations and Owners. April 1, 1942. New York, The National Foundation for Infantile Paralysis, Inc., 1942.
 Revista Cubana de Obstetricia y Ginecología (La Habana, Cuba), IV, Nos. 2 and 3-4, 1942.
 Revista Médica Municipal, III, Núm. 1, 1942.
 Roche Review (Nutley, New Jersey), VI, Nos. 8 and 9, 1942.
 The Rockefeller Foundation. A Review for 1941. By Raymond B. Fosdick. New York, 1942.
 Vida Nueva (Habana, Cuba), XLIX, Nos. 1, 2, and 3, 1942.

Current Literature

INTERNAL MEDICINE IN OLD AGE. Albert Mueller-Deham, M.D., and S. Milton Rabson, M.D. Baltimore, Williams and Wilkins Co., 1942. \$5.00.

Geriatrics is coming to the front in medical literature, and in this volume by Mueller-Deham and Rabson is a very comprehensive review of the bone, joint, and muscle lesions not uncommonly met with in elderly individuals.

Due to the war and other causes, it is estimated that in the next decade the number of inhabitants of this country above sixty-five years of age will have increased tremendously. Consequently the science of geriatrics is bound to be called upon to aid in prolonging the efficiency of the aged.

Citation of the great numbers of arthritic patients in this country and elsewhere emphasizes the fact that this is preeminently a disease of late adult life, and, therefore, one in which geriatrics is much concerned. Considerable space is devoted to the discussion of the types of chronic arthritis, which adheres pretty closely to the present-day classification. In the matter of treatment there was nothing added to present knowledge.

The descriptions of the onset and course of the diseases and the tissue changes that characterize them are very clearly set forth. Among the most interesting are osteoporosis, Paget's disease, osteomalacia, von Recklinghausen's disease, tuberculosis, syphilis, myositis, and other lesions of the muscles and ligaments. These are taken up and discussed briefly, but adequately. So far as treatment is concerned geriatrics is not at present, at least, in a position to do much more than cite the diseases most prevalent among the aged. Unless something pretty dramatic along the lines of treatment is forthcoming, it will be a good deal of a question how much interest the aged will manifest in the new specialty. They will be pretty much inclined to believe that the biblical author was right in what he said about life beyond three score and ten.

However, it is an interesting volume and contains much valuable information presented in an entertaining manner.

A TEXTBOOK OF SURGERY. American Authors. Edited by Frederick Christopher, M.D. Ed. 3. Philadelphia, W. B. Saunders Co., 1942. \$10.00.

The third edition of *A Textbook of Surgery* serves to bring up to date this book which sets a standard for textbooks of surgery for teaching and review purposes. The book is 1,718 pages in length, and contains 1,538 illustrations. There are 195 separate authors contributing to the work, almost all of whom are leaders in American surgery in various fields. The work represents an outstanding accomplishment in presenting a consensus of opinion in American surgery in summary form, and shows an enormous amount of effort in careful preparation to cover the entire field of surgery.

The book is divided into forty chapters, each chapter representing a section. Several chapters deal with the general basic principles and subjects in surgery, and toward the end of the book several other chapters deal with related subjects,—such as anaesthesia, and preoperative and postoperative care.

A section has been added to this edition of the book on the subject of war injuries, and deals with the types of injuries and their treatment. A brief mention of chemotherapy with the sulfonamide compounds is made, and a great deal of stress is laid on the Orr-Trueta method of treatment of fresh war injuries. Every specialty in the realm of surgery is represented by a section or chapter by outstanding American authorities, and the book seems an ideal one for the medical student. Of special interest to those interested in orthopaedic surgery are the chapters dealing with tendons, muscles and ligaments, bursae, orthopaedic surgery, amputations and prostheses, the bones, and frac-

tures and dislocations,—a total of seven chapters. The chapter on orthopaedic surgery requires almost exactly 100 pages, with many of the outstanding men in the specialty contributing parts of the section. It is presented in short and almost outline form, but is quite comprehensive enough for the medical student or the general practitioner who wants to look up something quickly, and find it in the form of a summary. The chapter on fractures is long, and about half of it is written by general surgeons rather than by orthopaedic surgeons; in a few places there are small points to which the orthopaedic surgeon might take exception. However, since the book is presented for the use of medical students and general men, great care has been used by the authors to keep the book as non-technical as possible; this is probably responsible for the method in which the treatment of some of the fractures is handled. It is most remarkable that a book, which is written by such a large number of authors, with the chapters divided into small sections, each distinct in itself, could at the same time include almost every conceivable subject in general surgery. It is sincerely felt that this textbook is a masterpiece, as far as being useful for the purpose for which it was prepared, and it should be on the shelf of every doctor for quick reference in any field of surgery with which he is not particularly familiar.

ARCHITECTURAL PRINCIPLES IN ARTHRODESIS. H. A. Brittain, M.A., M.Ch., F.R.C.S. With a Foreword by Harry Platt, M.D., M.S., F.R.C.S., F.A.C.S. (Hon.) Baltimore, The Williams and Wilkins Company, 1942. \$6.00.

The author has considered the subject of arthrodesis from a somewhat new point of view, and has developed his methods on architectural principles. His theory is certainly sound, especially as to stiffened joints which are to be the seat of strain. He has illustrated how the mechanical principles employed in cathedral structures can be applied in this surgery.

In his general discussion, in which he gives the indications for arthrodesis, he enumerates the usual causes of failure of success in arthrodesis, as: (1) inadequate apposition, (2) inadequate immobilization, (3) extension of disease, and (4) operations based on faultily conceived mechanical principles. He then presents the architectural principles which should be employed, and shows how they may be applied. The rules which he advocates are: (1) the graft should be placed with its long axis in compression rather than in tension, (2) the breadth of the graft should be placed in the position of maximum stress, (3) the joint should be locked by two grafts crossing each other in the shape of the letter X, and (4) there should be adequate protection of the graft. The employment of the force of compression rather than of tension makes use of a sound principle.

Each joint is described in detail, and the author shows in what way he has applied architectural principles in placing the graft to most effectively resist stress. With this is given the technique of operation, and excellent illustrations of the surgical anatomy of the region, also of the special method of shaping and removing the graft as well as preparing the bed for it.

The application of this principle in some of the joints is particularly ingenious. In the hip he has fulfilled Calvé's contention that the ideal graft of the hip should be based as an adduction buttress. The chip-graft method of spinal arthrodesis is also deserving of special comment.

Although small, the book is beautifully illustrated, including a number of colored prints. The author has made a definite contribution to this difficult problem.

THE PRINCIPLES OF ANATOMY AS SEEN IN THE HAND. Frederic Wood Jones. Ed. 2. Baltimore, The Williams & Wilkins Co., 1942. \$7.50.

The first edition, written during the excitement of the first World War, was published in 1920. The second edition has been prepared under similar conditions. The

entire text has been rewritten, and six chapters have been added. No pathological conditions are discussed.

The author feels that exact anatomy has not been given the attention that other branches of medicine have received. Physicians called upon to treat war injuries have begun to realize their need of anatomical knowledge. "War surgery is practical anatomy." A study of the anatomy of the hand brings out many principles which apply to other parts of the body.

A consideration of the comparative anatomy of primates helps to explain the development and physiological function of the hand.

Flexure lines are anatomical structures having definite relations to physiological functions. One must realize that, because of the presence of muscles and ligaments interposed between the joints and the skin, the flexure lines do not always mark the line of the joints. This point is demonstrated by reference to parts of the body other than the hand.

Excellent chapters have been written on cleavage lines, the papillary ridges, nails, and hairs. The fascia, bones, extrinsic and intrinsic muscles, joints, nerves, lymphatics, vessels, and sympathetic system have been discussed in great detail.

The illustrations in all chapters are excellent. Shaded drawings picture the nerve supply to various parts of the hand, the palmar arches, the tendon sheaths, the muscles, and the joints.

It is surprising that so much could be written on normal anatomy. Certainly, nothing of importance has been omitted.

DIRECTORY OF MEDICAL SPECIALISTS CERTIFIED BY AMERICAN BOARDS, 1942. New York, Columbia University Press, 1942. \$7.00.

The publication of this Directory so soon after the 1939 edition was made necessary by the fact that to the 14,000 Diplomates listed then, there have been added 4,000 additional, together with three new Boards, bringing the total number of Boards up to fifteen. The volume contains a biographical notation on every Diplomate, listed by state, town or city (in Canada by province and city), an alphabetical list, the names of the officers of each of the several Boards, and the qualifications to be met by those who aspire to certification.

As a reference book for those called upon to pass on the qualifications of any specialist, whether for personal or public service, this is a valuable aid.

LESIONES TRAUMÁTICAS DE LOS MENISCOS, LIGAMENTOS CRUZADOS Y LIGAMENTOS LATERALES DE LA RODILLA (Traumatic Lesions of the Meniscus and Cruciate and Lateral Ligaments of the Knee). José Valls. Buenos Aires, Caporaletti Hnos., 1941.

In this monograph Dr. Valls reviews the anatomy and traumatic pathology of the meniscus, cruciate ligaments, and lateral ligaments of the knee. He discusses and favors the belief that there is frequently a predisposition to tearing of the meniscus. This often comes from repeated minor traumata which lead to degenerative changes. He has studied carefully 200 cases of traumatic lesions of the meniscus, but has been unable to evaluate the exact importance of these degenerative processes in the meniscus. Reparative processes in the meniscus divided themselves into two types,—vascularization and fibrous repair. Complete repair was observed in one case. Degenerative changes were observed most frequently in mountainous regions and in people who had to do much climbing. Arthritis deformans frequently followed a lesion of the meniscus. As the injuries to the meniscus may vary greatly, so the mechanism producing the injury may also differ greatly. In a review of 373 clinical cases, the author found longitudinal ruptures in 53 per cent., ruptures of the anterior portion in 15 per cent., a tear at the capsular attachment in 10 per cent., transverse rupture in 5 per cent., and a variety of lesions in the remainder.

All of the diagnostic signs reported in the literature are reviewed. The author believes that roentgenographic examination after the injection of air is helpful. Arthroscopy has not been helpful, since too small a part of the articulation is seen. In 373 cases, arthritis was found in nine, osteochondritis in three, and rupture of the anterior cruciate ligament in three. The author discusses both conservative and operative treatment. He has found partial removal of the meniscus adequate. In dogs operated upon seven to nine months after partial extirpation of the meniscus, almost complete regeneration was observed. The meniscus was removed in twenty-two children. In twelve of these, congenital abnormalities of the internal meniscus were found. After operation in children, there is usually instability which disappears gradually.

The mechanism of producing tears of the cruciate ligaments is discussed—the chief factor being rapid rotation of the body with the knee fixed. Genu recurvatum leads to stretching of the cruciate ligaments. The author feels that no physical signs are always reliable in making a diagnosis, but that anteroposterior and lateral instability are of most value. There is a difference of opinion in regard to the importance of the cruciate ligaments. But in most instances the author has found rupture of one of them to lead to instability, hydrarthrosis, and muscle atrophy. If symptoms are not severe, conservative treatment may be followed,—such as immobilization in semiflexion for two months, with heat, massage, and exercise. The author believes that healing has occurred by such treatment in seven cases. The author has replaced the ligament by silk sutures which followed almost the same course as the original ligament. Lesions of the lateral ligaments are also repaired by long silk sutures.

The monograph is well illustrated and there is a complete review of all the pertinent literature.

FRACTURES OF THE PELVIS. WITH SPECIAL REFERENCE TO ASSOCIATED FRACTURES OF THE SACRUM. Warren W. Furey. *The American Journal of Roentgenology and Radium Therapy*, XLVII, 89, January 1942.

An analysis of ninety-six pelvic fractures occurring in a five-year period is presented. The sacrum was involved in sixty-five of these cases, automobile accidents being responsible for most of them. In accidents where the pelvis is fractured anteriorly, a sacral fracture may be easily overlooked. Since the percentage of posterior pelvic fractures in published reports is rather low compared with this series of cases, the author urges a deliberately thorough study of the sacrum in all cases of pelvic injury.

—Richard C. Batt, M.D., Berlin, New Hampshire.

TIME OF APPEARANCE AND FUSION OF OSSIFICATION CENTERS AS OBSERVED BY ROENTGENOGRAPHIC METHODS. H. Flecker. *The American Journal of Roentgenology and Radium Therapy*, XLVII, 97, January 1942.

This lengthy article contains detailed statistical information about normal epiphyseal development. Much of this data, especially that concerning the sesamoids and smaller bones, is difficult to find in the reference charts and textbooks commonly used by specialists.

The author comments on the striking discrepancy among anatomical authorities on epiphyseal development. Despite previously published data, a really comprehensive roentgenographic survey of the time of appearance, and the fusion of centers of ossification and epiphyses has not yet been undertaken. It is asserted that all tables of ossification contain many inaccuracies due to insufficient quantitative information.

His own figures on ossification were obtained from roentgenograms of patients in the Prince Henry Hospital and Women's Hospital in Melbourne. He modestly considers this material insufficient for graphing and therefore prefers to present the actual figures for each age group and each epiphysis in sixty detailed tables.—Richard C. Batt, M.D., Berlin, New Hampshire.

POST-TRAUMATIC PAINFUL OSTEOPOROSIS. A CLINICAL AND ROENTGENOLOGICAL ENTITY. Louis G. Herrmann, Harold G. Reineke, and John A. Caldwell. *The American Journal of Roentgenology and Radium Therapy*, XLVII, 353, March 1942.

The authors thoroughly discuss a clinical and roentgenographic entity characterized by (1) prolonged intractable pain in an injured extremity; (2) partial loss of motor function of the affected part; (3) localized vasomotor disturbances in the affected extremity; and (4) spotty demineralization of the bones at the site of the trauma. The importance of differentiating this condition roentgenographically from ordinary atrophy of disuse is stressed. A photograph of a hand, showing the typical oedema, trophic changes, and discoloration of the skin, illustrates one of the cardinal points of the syndrome.

Posttraumatic painful osteoporosis may occur following injury to a joint, with or without fracture. The type and severity of the trauma frequently influences the clinical course of the disease. The aching pain and impaired motor function are greatly out of proportion to the local signs of injury to the tissues. The aching pain cannot be relieved by immobilization, which fact differentiates an advanced case of the disease from tuberculosis or pyogenic arthritis.

A survey of the literature shows that posttraumatic osteoporosis can develop in any bone in the body including the skull. The hands and feet are most frequently affected. The development of the disease may be traced roentgenographically through three stages. At first, there is a general mottled rarefaction of the bones. As the rarefaction continues, the cortex becomes thinned. The cortical thinning may advance to such a degree that the margins of the bones appear poorly defined, and the entire area seems homogeneous. At this stage ankylosis may occur, resulting in permanent disability. During the stage of reconstruction, there is a slow reappearance of calcium in the bones.

The authors urge early diagnosis and active treatment. In their experience, periarthral sympathectomy is the best form of treatment. Forceful manipulation of the joints under anaesthesia is definitely contra-indicated.—*Richard C. Batt, M.D., Berlin, New Hampshire.*

THE ROENTGEN FINDINGS IN INCREASED LEAD ABSORPTION DUE TO RETAINED PROJECTILES. Hyman R. Senturia. *The American Journal of Roentgenology and Radium Therapy*, XLVII, 381, March 1942.

This article contributes two interesting cases of chronic lead poisoning, developing over a period of years from lead bullets lodged in bone. Roentgenograms show the original bullets in the wrist joint and femoral head. Follow-up studies five years later show arthritic changes with flocculent and fragmented deposits of lead in these joints. Symptoms of joint pain, nervousness, headache, dizziness, and sore gums had developed from increased lead absorption. A quantitative chemical analysis of the blood and urine for lead confirmed the diagnosis. After arthroplasty in one patient, with removal of the lead, the symptoms improved, and the abnormal lead levels in the blood and urine returned to normal.—*Richard C. Batt, M.D., Berlin, New Hampshire.*

BONE INFARCTS. S. C. Kahlstrom. *The American Journal of Roentgenology and Radium Therapy*, XLVII, 405, March 1942.

The high incidence of bone infarcts among caisson workers exposed to compressed air is well known. The author stresses the relative frequency of bone infarcts among individuals who have not been exposed to compressed air. The etiology of arteriosclerosis in the production of bone infarcts has been suggested previously by the works of Phemister, Chandler, and others.

The author's five cases of multiple bone infarcts include one caisson worker, three arteriosclerotic individuals, and one patient with neither a history of caisson disease

nor evidence of arteriosclerosis. The roentgenograms illustrate the characteristic well-defined, mottled areas of increased bone density involving the medullary portions of the diaphyses and sometimes extending into the epiphyses. Circinate patterns of calcification are typical. Biopsy material in these cases, however, is lacking.—*Richard C. Batt, M.D., Berlin, New Hampshire.*

POST-TRAUMATIC PARA-ARTICULAR OSSIFICATION OF THE KNEE JOINT (PELLIGRINI-STIEDA'S DISEASE). J. Kulowski. *The American Journal of Roentgenology and Radium Therapy*, XLVII, 392, March 1942.

The author reports eleven additional cases of this disease. The case reports are preceded by a thorough, orderly, and concise description of all phases of the disease. The roentgenographic findings are given in detail.—*Richard C. Batt, M.D., Berlin, New Hampshire.*

ATYPICAL GIANT CELL TUMOR. Bradley L. Coley and Lawson E. Miller. *The American Journal of Roentgenology and Radium Therapy*, XLVII, 541, April 1942.

Distinctly atypical cases of giant-cell tumor are rarely encountered. However, the importance of recognizing them is obvious, for unless their true nature is appreciated, the proper treatment cannot be carried out. The necessity of biopsy in such cases is inferred.

The atypical cases may be divided into two groups: (1) atypical because of clinical and pathological criteria, and (2) atypical because of location.

In the latter group it is essential, of course, to recognize the benign nature of the lesion, so that conservative treatment can be employed. In the former group, the cases are either malignant from the time they are first observed, or they become malignant following unsuccessful treatment. The authors mention several unquestionable examples of malignant transformation in previously benign giant-cell tumors.

Seven case reports with roentgenograms and biopsy material are presented. It is interesting that roentgenographically the malignant cases all showed osteoclasts with cortical and periosteal involvement. An exception to this is a case with Codman's epiphyseal chondromatosis giant-cell tumor of the humerus.—*Richard C. Batt, M.D., Berlin, New Hampshire.*

WAR WOUNDS. John J. Moorhead. *The American Journal of Surgery*, LVI, 338, May 1942.

The author, recently returned from Pearl Harbor and its war casualties, again stresses his former teachings, and adds his clear suggestions to aid all surgeons in the better care of present-day war casualties.

The three essentials of trauma are shock, hemorrhage, and infection. The first two can be handled by external heat, fluids, and whole blood, or liquid or dried plasma.

The basic elements of wound treatment are:

1. Time,—within six hours after trauma;
2. Cleanliness,—washing the parts with soap and water;
3. Débridement,—removing all damaged tissue until three criteria are attained:
 - a. The parts look healthy,
 - b. Bleeding is present at the excised edges,
 - c. The muscle contracts;
4. A dry wound;
5. Sterilization,—the use of a sulfonamide, preferably sulfanilamide;
6. Sutures,—primosecondary sutures or none at all;
7. Dressings,—heavy gauze and cotton applications, plus splinting if there are nearby joints, and elevation and tilting to promote drainage;
8. After-care,—a sulfonamide by mouth and redressings after three days.

POST-TRAUMATIC PAINFUL OSTEOPOROSIS. A CLINICAL AND ROENTGENOLOGICAL ENTITY. Louis G. Herrmann, Harold G. Reineke, and John A. Caldwell. *The American Journal of Roentgenology and Radium Therapy*, XLVII, 353, March 1942.

The authors thoroughly discuss a clinical and roentgenographic entity characterized by (1) prolonged intractable pain in an injured extremity; (2) partial loss of motor function of the affected part; (3) localized vasomotor disturbances in the affected extremity; and (4) spotty demineralization of the bones at the site of the trauma. The importance of differentiating this condition roentgenographically from ordinary atrophy of disuse is stressed. A photograph of a hand, showing the typical oedema, trophic changes, and discoloration of the skin, illustrates one of the cardinal points of the syndrome.

Posttraumatic painful osteoporosis may occur following injury to a joint, with or without fracture. The type and severity of the trauma frequently influences the clinical course of the disease. The aching pain and impaired motor function are greatly out of proportion to the local signs of injury to the tissues. The aching pain cannot be relieved by immobilization, which fact differentiates an advanced case of the disease from tuberculosis or pyogenic arthritis.

A survey of the literature shows that posttraumatic osteoporosis can develop in any bone in the body including the skull. The hands and feet are most frequently affected. The development of the disease may be traced roentgenographically through three stages. At first, there is a general mottled rarefaction of the bones. As the rarefaction continues, the cortex becomes thinned. The cortical thinning may advance to such a degree that the margins of the bones appear poorly defined, and the entire area seems homogeneous. At this stage ankylosis may occur, resulting in permanent disability. During the stage of reconstruction, there is a slow reappearance of calcium in the bones.

The authors urge early diagnosis and active treatment. In their experience, periarthral sympathectomy is the best form of treatment. Forceful manipulation of the joints under anaesthesia is definitely contra-indicated.—*Richard C. Batt, M.D., Berlin, New Hampshire.*

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The most effective oxidizing substances are: in powder form zinc peroxide; in ointments and pastes, azochloramid and zinc peroxide; in solution, iodine, azochloramid, and potassium permanganate.

Wound healing is not appreciably inhibited by the presence of these drugs which, as demonstrated by serum studies, are absorbed from the wounds into the general circulation. Only three instances of idiosyncrasy to local use were encountered.

The author suggests that if every combatant on the field of battle carried potentiated sulfonamide powder for immediate use, a sharp decline in gas gangrene, amputations, and complications subsequent to suppuration could be anticipated.—*Custis Lee Hall, M.D., Washington, D. C.*

DYSTROPHIA MYOTONICA IN INFANTS AND CHILDREN. Otto Maas. *The British Journal of Children's Diseases*, XXXVIII, 59, 1941.

Dystrophia myotonica (atrophica) is an endogenous hereditary disease of the nervous system, usually affecting many persons of different generations in the same family. It is characterized by muscle weakness, wasting, and cataracts. The author believes that the condition is found in children and that it should not be distinguished from Thomsen's disease where wasting and cataracts are not found. He has found Thomsen's disease among the children of fathers suffering from dystrophia myotonica. Some show only slight wasting of the temporal muscles, stiffness of the hand, or mental retardation; some find their way to reform school or prison. Later in life the muscle weakness and atrophy become more evident, and cataracts, baldness, and rigidity of muscles impeding active movements—stiff fingers for instance—develop. These patients differ from true spastics in that they can carry out certain movements normally, after having made the same movements several times in succession. There is also a passive excitation of muscles,—that is, if the thenar muscles, for example, are percussed the muscles contract quite slowly and the thumb is held in opposition position for several seconds.

The author illustrates his article with several case histories. The children need special guidance. No cure has as yet been discovered.—*R. T. Boyd, M.D., Iowa City, Iowa.*

SPONDYLOLISTHESIS AFFECTING THE FOURTH LUMBAR VERTEBRA. William MacL. E. Topping. *British Journal of Radiology*, XIV, 162, 1941.

Two cases of spondylolisthesis affecting the fourth lumbar vertebra are reported, occurring in middle-aged laborers who complained of pain in the back. There was no history of definite antecedent trauma in either case. The displacements were estimated to be one-third of an inch. Roentgenographic examination demonstrated the underlying pathological anatomy to be similar to that which is known to be present in the much more common site of spondylolisthesis,—namely, the fifth lumbar vertebra.—*J. E. Fuchs, M.D., Iowa City, Iowa.*

SPONTANEOUS FRACTURE OF THE APPARENTLY NORMAL NECK OF THE FEMUR. Kenneth S. Mullard. *British Journal of Surgery*, XXIX, 241, 1941.

In a healthy man of twenty-seven, while undergoing very vigorous army training, involving long hikes and runs, severe pain and disability developed in his femur. A roentgenogram showed a linear fracture, without displacement, one-half inch proximal to the intertrochanteric line. With conservative treatment, healing occurred in seven weeks, with a minimum amount of callus formation.

The resemblance of this "spontaneous" fracture to march fractures is noted in that: (1) there was no history of injury, (2) there was a definite history of repeated severe physical strain, (3) there was gradual increase in disability, but quick relief from rest, and (4) the texture of the bone as seen in roentgenograms was normal.—*Ernest M. Daland, M.D., Boston, Massachusetts.*

AN UNUSUAL CASE OF LOOSE BODY IN THE ELBOW-JOINT. N. Vere-Hodge. *British Journal of Surgery*, XXIX, 274, 1941.

A man, thirty-five years of age, who had sustained a fracture of both bones of the forearm twenty years before, complained of locking in his elbow joint. Roentgenograms showed a loose body in the elbow joint, with a cavity in the olecranon fossa into which the body was thrust on extension. The loose body was removed and proved to be hyaline cartilage with a covering of calcified material.—*Ernest M. Daland, M.D., Boston, Massachusetts.*

THE SKELETAL AND OTHER CHANGES FOUND IN A CASE OF SUPRASellar CYST OF RATHKE'S POUCH. R. A. Rowlands and S. L. Simpson. With a Pathological Report by Dorothy S. Russell and H. M. Turnbull. *British Journal of Surgery*, XXIX, 304, 1942.

This is a case report of a man of forty-three years with a mental and physical development of a boy of twelve. No secondary sex development had occurred. One year before admission to the hospital, he began to have severe headaches several times a week, instead of occasionally as he had had during the previous twenty years. He had momentary attacks of unconsciousness and slept a great deal of the time.

The bone changes are described as follows: "The sella turcica is shallow and the dorsum sellæ is eroded from above downwards; . . . [it] suggest[s] the presence of a calcified suprasellar cyst. The bones of the forearm are very small and thin, and show osteoporosis, but there is no abnormality of texture. The epiphyses of radius and ulna (lower end) remain ununited with the shaft. All the bones of the hand are small, and all epiphyses are ununited. There is no pelvic deformity. The head of both femora are united but 'mushroomed'; the head of the left femur shows a peculiar cystic appearance; there is a loose body in the region of the right acetabulum. The epiphyses of the knee-joints are ununited." Later examination showed disorganization of the hips, with osteo-arthritic changes, eburnation and flattening of the heads of the femora, and numerous large osteophytic bodies.

At autopsy, a suprasellar cyst of Rathke's pouch was demonstrated.—*Ernest M. Daland, M.D., Boston, Massachusetts.*

MONTEGGIA FRACTURES. Arthur Naylor. *British Journal of Surgery*, XXIX, 323, 1942.

Monteggia, in 1914, described two cases of fracture of the upper third of the ulna, with dislocation of the head of the radius. Since then his name has been attached to this type of fracture.

The usual site of this fracture of the ulna is three or four inches below the tip of the olecranon process, and an anterior dislocation of the head of the radius is associated with it. It is usually caused by direct violence applied to the ulna. Continued pressure tends to force the fragments of the ulna apart; the force is transmitted through the interosseous membrane to the radius, with rupture of the orbicular ligament and dislocation of the radial head, either anteriorly or laterally.

For treatment, the author disagrees with the methods of "transatlantic workers" that open operation should be done. He believes that the radial dislocation should be recognized early and reduced by closed methods.

The results in nine cases are not fully stated. He states that in three cases extension was limited to 130 to 160 degrees. In four cases there was complete restoration of function, and in one pronation was limited. Open operation was attempted in one case two weeks after injury, but the ultimate result showed limitation in pronation and extension.

This series is small and includes several children. Two of the dislocations of the radial head were lateral and one was posterior. Three fractures were compound. No real conclusions can be drawn.—*Ernest M. Daland, M.D., Boston, Massachusetts.*

THE TREATMENT OF NEUROGENIC URINARY INCONTINENCE WITH TRASENTIN. Irving Simons. *Bulletin of the Hospital for Joint Diseases*, III, 26, 1942.

Simons notes that after injuries to the brain or cord, with various types of compression, and after neoplasms, systemic disease, and vertebral injuries, dystonia of the bladder may result. Briefly, the neurogenic dystonias of the bladder may be divided into the hypotonic and hypertonic types. The hypotonic bladder is characterized by hyposensitivity, large bladder capacity, a residual urine, and pseudo-incontinence.

The hypertonic bladders are hypersensitive, of small capacity, and present true incontinence. They are usually to be attributed to interference with the fibers of the pyramidal tract, which carry the inhibitory impulses to the parasympathetic centers in the conus. The differentiation between these two types is readily made by means of cystometric and sphincterometric studies.

In the hypertonic type of neurogenic bladder, depressant therapy is indicated. To avoid the undesirable effects of atropin, the author has used trasentin,—a synthetic proprietary drug which is believed to depress the effector endings of the parasympathetic nerves. It has been given clinically in divided daily doses of 600 milligrams which are increased to as much as 900 milligrams at times. In a series of cases to be reported later, the author observed complete relief of incontinence in 50 per cent., and improvement in 20 per cent. of his cases.

These patients were followed for a period of six months following withdrawal of the drug, without recurrence of the symptoms. A typical case in which incontinence developed following laminectomy is reported.—*Henry Milch, M.D., New York, N. Y.*

THE KENNY TREATMENT OF INFANTILE PARALYSIS DURING THE ACUTE STAGE. Philip Lewin. *Illinois Medical Journal*, LXXXI, 281, April 1942.

In this article, Dr. Lewin gives a clear and accurate analysis of the Kenny method of treatment, to which he has given study and personal observation in different clinics in which it has been used. He states the principles and the method of application of the treatment, the technique of which he discusses in detail, and makes a fair and unprejudiced estimate of the results obtained. He discusses and interprets the theory of Miss Kenny's method, which is aimed at: the abolition of muscle spasm, the substitution of mental "awareness" for the pathological "alienation", and the restoration of coordination of muscle activity, and includes:

1. Proper bed placement,—natural rest position.
2. A foot-board to preserve the "standing reflex".
3. Hot fomentations to relieve pain and muscle spasm.
4. Special analysis, classification, and reeducation of muscles.
5. Passive movements.
6. Concentration of active movements on the insertions of muscles and tendons.
7. The abandonment of all splints, respirators, and artificial feeding.

Dr. Lewin's discussion of the theory of muscle spasm, rather than paralysis, is particularly helpful. He expresses a very favorable opinion of the Kenny treatment, as shown by her results, and in his summary he states that it is one of the outstanding advances in orthopaedic surgery.

COMPRESSION OF BRACHIAL PLEXUS: THE SCALENUS ANTICUS SYNDROME. Frederick Leet Reichert. *The Journal of the American Medical Association*, CXVIII, 294, January 24, 1942.

In this article the author reports the relief of symptoms of compression of the brachial plexus by non-surgical means in sixty of seventy-four patients. In the past much attention has been paid to surgical relief of symptoms by removing cervical ribs, and by section of the scalenus anterior as popularized by Ochsner, Gage, and De Bakey. Little has been written of the non-surgical method of relief described by Theis in 1939

and Stopfort in 1919, but the results obtained by the author equalled, and in some instances surpassed, those reported with use of the surgical method.

The symptoms of brachial compression due to displacement are the same as those produced by compression over a cervical rib. Compression of the brachial plexus sets up a vicious cycle produced by the constant friction of the plexus. There is an irritation of the branch supplying the scalenus anterior which causes spasm of the muscle, in turn causing the raising of the first rib. This increases the sharp angle between the scalenus anterior and the first rib, producing further compression of the plexus and subclavian artery. The symptoms include pain, numbness, tingling, hyperaesthesias, and paraesthesias anywhere in the distribution of the involved nerves, particularly in the distribution of the nerves from the medial cord which is most affected. There may be cyanosis, coldness, and sometimes gangrene, due to decreased blood resulting from compression of the subclavian artery. All symptoms are aggravated by anything which tends to increase or maintain tension of the scalenus anterior.

The author, in treating the syndrome, used surgical and non-surgical methods. In fourteen patients, section of the muscle was done. Ten of these received complete relief; two had to be reoperated upon; one obtained relief only after procaine injections, and one died of hemorrhage. Good relief of symptoms was obtained in sixty patients by the use of non-surgical conservative methods. These measures included:

1. Elevation of the shoulder by means of a sling.
2. Elimination of work which puts tension on the scalenus anterior and aggravates symptoms.
3. Change and correction of sleeping habits. Over two-thirds of these patients complained of pain more severe at night. It was found that many of these slept with no pillow or only one. By arrangement of pillows in such a way as to get maximum relaxation of the muscle and to overcome the squeezing mechanism, good relief was obtained. Three pillows were arranged in a sort of V, so that when the patient is on his back, his head and neck are thrown forward; and when on his side, the affected shoulder, as well as the head, is elevated by a pillow. When the painful side is up, a pillow should be placed between the arm and the body, or the patient should sleep with the arm above the head.—
Sidney L. Stovall, M.D., Dallas, Texas.

NECK PAIN. THE LAMINOGRAPH AS AN AID TO THE DIAGNOSIS OF ATLANTO-OCCIPITAL LESIONS. Frederick A. Jostes. *The Journal of the American Medical Association*, CXVIII, 353, January 31, 1942.

The author reviews the neck symptoms, of which no diagnostic procedure revealed the true pathology, even though they respond to treatment. With the advent of the laminogram, a new field of pathological possibilities has been opened up by discarding the overlying maxilla and presenting only the plane of the occipital condyle. Following careful study of the normal relationship of the anatomy of the atlanto-occipital region, the laminograms can be accurately interpreted and the lesion diagnosed.

The author presents several cases to show the true benefit of the laminogram.

Treatment consists in head traction, which the patient can carry out at home, supplemented by heat and other types of support as indicated.—*D. K. Barnes, M.D., Dallas, Texas.*

TREATMENT OF ARTHRITIC JOINTS. Robert J. Joplin and George J. Baer. *The Journal of the American Medical Association*, CXVIII, 937, March 21, 1942.

The authors describe and illustrate orthopaedic measures to prevent deformities during the treatment of rheumatoid arthritis. They have reviewed and summarized the apparatus in use by the Boston orthopaedic group, and have added modifications of their own. Special attention is given to the prevention of deformities of the shoulder, elbow, wrist, hand, spine, hips, knees, and feet.

The article is illustrated with photographs to show pulley-exercising apparatus for

the shoulders; cock-up splints for the wrists; banjo splints for the fingers; corsets; head traction; ambulatory hip spicas; bivalved plasters, caliper splints, and cylinder casts for the knees; and foot supports.

This is an excellent article to point out simple apparatus which may be used by general practitioners to prevent deformities in patients with progressive rheumatoid arthritis.—*H. C. Coggeshall, M.D., Dallas, Texas.*

INTRASPINAL OPERATIONS IN COMPENSATION CASES. Arthur Ecker. *The Journal of the American Medical Association*, CXIX, 128, May 9, 1942.

Pneumograms of the spine were made in fifty cases and thirty-eight patients were operated upon, twelve of whom claimed compensable disability. The ages of the patients ranged between twenty and fifty-three years; the preoperative duration of the symptoms was from three months to fourteen years; twelve different occupations were represented.

Cases of prolonged sciatic pain are due to mechanical irritation of the nerve roots, and diagnosis of intraspinal pressure on the nerve roots was made on the history and physical examination. The usual case gave a history of onset while bending forward or straining, early development of backache, later development of sciatic pain, limp on the affected side, increase of pain on coughing or sneezing, relief of pain with bed rest, painful and limited straight-leg raising, limitation of flexion of the lumbar spine, list of the back, paraesthesia especially in the fifth and first sacral dermatome, diminished or absent ankle jerk, tenderness over the sciatic nerve, elevated protein of spinal fluid, and localized tenderness at the site of the lesion. Clinical diagnosis takes precedence over a normal pneumogram. In all patients operated upon, laminectomy of the fifth lumbar vertebra was performed. In addition the thickened ligamentum flavum or the protrusion of the intervertebral disc, or both, were removed. No corset or back brace was prescribed postoperatively. Patients were kept in bed ten days, and in the hospital twenty-one days. They were able to return to part-time light work in sixty days, and to their usual work in four months. Every patient apparently was promptly and permanently relieved of severe pain.—*John K. Coker, M.D., Dallas, Texas.*

THE SCALENUS ANTICUS SYNDROME. Bernard D. Judovich and William Bates. *The Journal of the International College of Surgeons*, V, 26, January-February, 1942.

Calling attention to the syndrome of pain in the shoulder, arm, and hand described by Naffziger and attributed by him to a tightened scalenus anterior, the authors elaborate on the etiological mechanism. They believe that an occasional anomaly of the muscle is encountered in which a slip of the muscle passes behind the subclavian artery, and that hypertrophy of the muscle causes pressure on the subclavian artery, the brachial plexus, and the cervical sympathetic nerves either directly or through elevation of the first rib. In spite of this localized pressure mechanism, that should involve only roots from the fourth cervical to the second thoracic at the most, their case reports indicate the coexistence of pain in the cervical plexus and in thoracic roots as low as the fifth thoracic, but no explanation is offered to show how the taut scalenus anterior can produce the pain. The treatments used by them were:

1. Procainization of the muscle by a technique that is carefully described.
2. Cutting of the scalenus anterior.

They indicate that the procaine injection is at times productive of an undesirable complication,—a Horner's syndrome.—*I. William Nachlas, M.D., Baltimore, Maryland.*

OBSERVATIONS AND PROBLEMS ON OPERATION FOR LESIONS OF THE SEMILUNAR CARTILAGE. Felix Mandl. *The Journal of the International College of Surgeons*, V, 63, January-February, 1942.

The observations are based on 840 cases of pathology of the semilunar cartilage treated by the author by operation. It is noted that the incidence of ruptured menisci

is greater now, chiefly because of the increase in sports and "particular-position" occupations. A major trauma is not essential to the production of a rupture. Pathological fractures can take place in cartilages which have undergone degenerative changes. Tearing of the cartilage is more prevalent in medial menisci, while cysts are more frequently found in the lateral ones. This may in part be due to the fact that in the newborn the outer meniscus still consists of hyaline cartilage. In the determination of which cartilage is torn, the author finds Bragard's sign of great value. Roentgenograms have been helpful in older patients, when calcification has taken place. Though he does not operate when the injury is acute, chiefly because he feels that an accurate diagnosis cannot be made at that time, he considers arthrotomy the only rational treatment when the rupture is recognized. Though regeneration of the removed cartilage can take place, the "regenerate" is of connective tissue. The operations are performed without a tourniquet and under local anaesthesia. To reduce the postoperative effusion, a window is cut in the suprapatellar pouch. Immobilization is made by a posterior splint, and early movement is encouraged. He reports "lasting good results" in 95 per cent. of his cases.—*I. William Nachlas, M.D., Baltimore, Maryland.*

THE TREATMENT OF FRACTURES OF THE FEMORAL NECK IN THE AGED. Herman de Las Casas. *The Journal of the International College of Surgeons*, V, 98, March-April, 1942.

In a study of the end results following internal fixation of fractures of the neck of the femur, the author is impressed by the large number of "failures". The greatest difficulty, granted that satisfactory reduction has been accomplished, lies in the fact that a necrosis of the head of the femur takes place. In some instances there is a gradual shortening of the neck of the femur.

A careful study of the circulation of the upper end of the femur was made, and revealed the fact that, in the aged, the blood vessels are inadequate to supply the nutritional needs for healing of the broken bone. The distribution of the vessels is such that fractures of the neck break the line of food supply, so that an aseptic necrosis takes place. This is particularly true in subcapital fractures. The author, therefore, feels that in most instances of subcapital fractures, an operation designed to remove the head is preferable. In the other cases, he prefers autogenous grafts as his method of internal fixation. Above all, he stresses the fact that it is necessary to individualize the patient. The article contains a great deal of valuable information and is worth reading in detail.—*I. William Nachlas, M.D., Baltimore, Maryland.*

TRAUMATIC CONDITIONS OF THE WRIST. F. G. Hodgson. *The Journal of the Medical Association of Georgia*, XXXI, 66, February 1942.

Three of the more common disabilities of the wrist are described, and their appropriate treatment is given. For Colles' fracture, after accurate reduction, a non-padded plaster-of-Paris splint is applied; is held in place by a three-inch bandage; and extends from the metacarpophalangeal joint to the elbow. This should be worn for five weeks without interruption, and the use of the hand and fingers should be encouraged from the very beginning. If the fingers are properly used and exercised, very little stiffness or disability will be present when the splint is removed.

Fracture of the carpal scaphoid is discussed. With prolonged immobilization of the hand in plaster, which does not prevent use of the fingers, union practically always occurs, and operation is not necessary.

Dislocation of the carpal navicular should be reduced early by manipulation. If seen late, operative removal of this bone is advised.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

VITAMIN B₆ (PYRIDOXINE HYDROCHLORIDE) IN THE TREATMENT OF PSEUDOHYPERTROPHIC MUSCULAR DYSTROPHY AMONG CHILDREN. Haddow M. Keith. *The Journal of Pediatrics*, XX, 200, 1942.

The author treated ten boys with vitamin B₆. The five oldest (ten to twelve years)

were unable to walk or stand; two (seven and nine years) walked with marked lordosis and typical waddling gait; and the three youngest (three years and nine months to five years) were able to walk without much assistance.

With a simple apparatus of rope, weights, pulley, and arm and foot rests, the strength of the pectoral and gluteal muscles was tested in all but two patients. One of these was too young to give good cooperation, and the other was too weak to operate the apparatus.

Contrary to the experience of others, the author found that the intramuscular injection of vitamin B₆ in amounts of 100 to 200 milligrams weekly for two to eight months, did not produce any measurable improvement in the strength of the pectoral and gluteal muscles, or any increase in general muscle strength which could be noted.

Vitamin B₆ in these amounts did not have any deleterious effect either general or local.

A CASE OF LEPROSY WITH CHARCOT'S JOINT. R. Subramaniam. *Journal of South Indian Medicine*, VII, 134, 1941.

The author reports an unusual case of leprosy, under treatment for seven years, in which the outstanding feature was a Charcot joint of the left ankle and foot. Roentgenograms showed rarefaction and absorption, particularly of the navicular and the fourth metatarsal. The author discusses the differential diagnosis between leprosy, syringomyelia, and tabes dorsalis.

The treatment advised was conservative: glycerine magnesium sulphate packs to the affected leg, and continued use of chaulmoogra oil.—Robert M. Green, M.D., Boston, Massachusetts.

ON CALVÉ'S DISEASE (So-Called Flat Vertebra). L. L. Lutrovnik. *Khirurgiya*, V, 85, 1941.

The author gives a description of the pathology and the phases of the disease. A history of an early occurrence of the disease in a patient seventeen months old is presented, followed by an observation of the clinical and roentgenographic development until recovery. At the age of two years and nine months, the patient showed complete clinical recovery and a marked regeneration of the vertebral body. However, the complete height of the vertebral body was not restored. In his conclusions, the author states that Calvé's disease is not rare and may be observed at a very early age. It is a disturbance of the normal growth of the vertebra, and in the earlier stage, about the fourth to the sixth week after the onset, it has the roentgenographic and clinical appearance of acute tuberculous spondylitis. The treatment should be conservative, persistent, and long. Full weight-bearing should not be permitted until definite signs of recovery are evident.—

Emanuel B. Kaplan, M.D., New York, N. Y.

THE GENESIS OF RACHITIC EXOSTOSES OF THE TIBIA. Z. A. Landress. *Khirurgiya*, V, 90, 1941.

The author made an anatomical and clinical study of the etiology of rachitic exostoses in the tibia. Personal observations indicated that these exostoses are observed only in patients in whom genu valgum is accompanied by a valgus curvature of the tibia. The author further noticed that, in the cases of genu valgum, where the inclination of the articular line only was changed, no exostoses were observed. Histologically, the exostoses are metaplastic ossifications of the tendon of the flexor digitorum longus, with subsequent osteoblastic bone formation in the insertion areas. They are produced by the constant stretching of the medial collateral ligament and the flexor digitorum longus. The presence of pes planus further increases the pull of the flexor digitorum longus and produces a flexion deformity of the toes and an adduction of the forefoot.—Emanuel B. Kaplan, M.D., New York, N. Y.

THE SALVAGING OF FRACTURE OF THE FEMORAL NECK. Royal Whitman. *The Lancet*, I, 378, March 28, 1942.

In this article, Dr. Whitman presents clearly and accurately the development of the treatment of fracture of the neck of the femur from the time when it was considered beyond the limit of successful surgery. It is evident to those who have had the opportunity of observing the gradual change in treatment, that the improvement began with Dr. Whitman's method of employing the abduction principle. He made use of an entirely new mechanical principle, and brought about the recognition of the value of the abduction method. Practically all of the methods since devised, which have contributed to the development of the treatment of this injury, have been based on the fundamental principle of the use and the mechanics of the abduction position. Even the use of the graft, and the later methods of metal fixation, bring in this principle, but with internal, rather than external, means for its accomplishment.

The review of the treatment for this fracture is given very clearly and interestingly in this article, and its presentation is timely. The history of its development should not be lost at this time when the treatment is becoming so much more definitely successful, and it would be well for the younger generation to be familiar with the rather remarkable development of the treatment of this difficult problem which was begun at the time when the x-ray was not available to give that aid without which the successful application of the methods today would not be possible.

PREVENTION OF HAMMER-TOE BURSITIS. Kenneth McFadyean. *The Lancet*, I, 474, April 18, 1942.

The author points out that, in the hammer-toe deformity, most of the pain arises from attacks of acute bursitis in the small bursa which early develops over the head of the first phalanx as a result of friction between the toe and the shoe. He outlines a treatment which consists of a well-fitting shoe of standard type and a stock wooden tree which accurately fits the selected shoe. Usually this can be secured without going to the expense of having a tree made. A small metal dome should then be attached to the tree at the site of the toe deformity and every new shoe should be stretched by this tree, first by itself, and then for a further period with a thin sock and later with two thin socks covering the tree. The author recommends purchasing shoes three months before they are to be worn.—*Lenox D. Baker, M.D., Durham, North Carolina.*

TREATMENT OF INTRACAPSULAR FRACTURES OF THE FEMORAL NECK. A. S. Blundell Bankart. *The Lancet*, I, 250, February 28, 1942.

The author does not present a series of cases, but indicates some points which seem to call for further consideration if the Smith-Petersen nail or similar devices are to be placed on a surer basis. In discussing the selection of cases, the author points out several feasible contra-indications for nailing, and in some instances he feels that it is better to do a transtrochanteric osteotomy at once, rather than to wait for the failure of a nailing operation. He recalls that the impacted subcapital abduction fracture always heals with bony union if it is treated in a short walking plaster spica, and he suggests that weight-bearing on an impacted fracture is not in itself harmful, so long as the joint is not moved, and he considers whether this has any bearing on the treatment of adduction fractures after internal fixation. He questions whether, in fact, the nailed adduction fracture should not be treated in the same way as the impacted abduction fracture,—in a short walking plaster spica. When cases unsuitable for nailing have been eliminated, the principal causes of failure are: imperfect reduction of the fracture, faulty application of the nail, and inappropriate after-care. In reducing the fracture, he feels that well-leg counter traction is the best method, as this can be adjusted at leisure, and when the reduction is perfect the patient can be lifted safely on the operating table with the traction still on the limb. In inserting the nail, he points out that the more vertically

the nail is placed, the less will be the breaking strain across it, and the more will the proximal fragment be guided towards and pressed against the distal fragment by pressure from above, and he states that the best angle for the nailing is one of 140 degrees with the long axis of the shaft of the femur. He points out that a nail can hold fragments apart as well as hold them together. He feels that the common practice of forbidding weight-bearing for some months after the operation while encouraging active movement of the hip should be reconsidered, and he gives reasons for believing that early weight-bearing should be encouraged while movement of the hip should be prevented until bony union has taken place. He outlines his technique for the nailing operation, and points out the importance of anchoring the proximal fragment to the pelvis while the nail is being driven in, in order to avoid displacement of the head by the oncoming nail. The article is most timely and contains many excellent suggestions.—

Lenox D. Baker, M.D., Durham, North Carolina.

DISUSE ATROPHY OF SKELETAL MUSCLE. J. C. Eccles. *The Medical Journal of Australia*, II, 160, 1941.

This paper describes preliminary investigations into the physiology of muscles suffering from disuse atrophy, and is also an attempt to discover the daily dosage of stimulation required to prevent the atrophy. This latter study has clinical significance in relation to the prevention of the disuse atrophy which occurs during immobilization when limbs are in plaster casings or when patients are kept in bed for long periods.

In twenty cats, muscles of the hind limbs were made completely inactive for several weeks by section of the spinal cord in the upper lumbar region and of all the dorsal roots below this level. The innervation of the muscle remained normal, but it atrophied because of disuse. The moist and dry weights of the muscles investigated fell to about 60 per cent. of normal in three weeks. The tetanic contraction strength fell still further.

An attempt was made to prevent disuse atrophy by tetanizing the motor nerve for different periods daily in different experiments, this artificial exercise being made as nearly normal as possible. It was surprising to find that all daily periods of tetanization, from ten seconds to two hours, had a similar effect. The greatest benefit was noted in the tibialis anterior and in the extensor digitorum longus. The gastrocnemius and the soleus showed the least change from the stimulation.

It is concluded from these experiments that the usual periods of stimulation in electrotherapeutic practice are much too long. Attention should be directed toward only a few minutes of stimulation daily, and to additional passive and active motions.—

H. M. Childress, M.D., Charleston, South Carolina.

A COMPARISON OF THE EFFECTS OF DISUSE AND DENERVATION UPON SKELETAL MUSCLE. G. Reid. *The Medical Journal of Australia*, II, 165, 1941.

It has long been shown that mammalian skeletal muscle undergoes definite morphological changes following division of its nerve supply. The problem is whether the atrophic changes in muscle consequent to denervation are due simply to disuse, or whether they are to be explained in terms of the lack of some influence, other than motor impulses, of the anterior horn cell on the muscle fibers which it supplies. It has been suggested that such a trophic influence might be comparable with that which exists between a nerve cell and its processes, and which is concerned with the integrity of the whole cell as a living unit. Experimental disuse of muscle has been brought about by tenotomy and by immobilization of such muscles in plaster casings. In such cases, however, the nervous system has been left intact.

Lumbar laminectomies were performed on cats with the cord being divided above the fourth lumbar and below the second sacral segments. The intervening dorsal roots were divided on both sides, but the ventral roots were only divided on one side. Both hind limbs were then encased in plaster. Experiments were made on the affected muscles at varying periods.

Conclusions were that morphological changes in skeletal muscle five to six weeks following denervation are not entirely due to disuse. The nuclear changes in the tissues on the denervated side were markedly increased as compared to such changes on the disused side.—*H. M. Childress, M.D., Charleston, South Carolina.*

CAUSATION OF FRACTURES OF THE NECK OF THE FEMUR. E. Sandner and E. C. Thompson. *The Medical Journal of Australia*, II, 383, 1941.

The mechanism of causation of fractures of the neck of the femur has never been satisfactorily explained. Fractures resulting from a fall have a definite traumatic factor to explain their occurrence; but in the case of those occurring from a trip or a false step, the traumatic factor is not so obvious. It appears that the solution of this problem lies in the understanding of the mechanics of the hip joint, together with the spring or shock-absorbing mechanism of the leg.

The author explains the spring action of the muscles and arches of the feet, and shows how such protection is aided by the muscles of the knee and the hip. In brief, in well-nourished individuals under ordinary circumstances, the femoral neck is well protected. The situation is not the same when a waddling elderly lady trips. When the posterior foot is moved forward it becomes caught in some object. The body weight continues to move forward while the victim attempts to extricate the foot by elevating it. Once the foot is released it is moved forward to prevent a fall. The knee is in extension and the pelvis on the same side is elevated with the thigh adducted. No shock-absorbing mechanism can work as the body is brought to a sudden stop, and a force of great magnitude is suddenly applied to the head of the femur. It is not unusual for elderly people to sustain such fractures without accompanying falls.

In order to check their estimations as to the cause of femoral fractures, the authors constructed models of the pelvis and hips made of five-ply timber. The results agreed with the theoretical values within 5 to 10 per cent. From the results, when any angularity of muscle action is taken into account, the vertical force at the head of the femur is approximately two and one-half times the weight of the trunk plus one leg.

The collection of clinical evidence is too meager and the number of cases too small, according to the writers, for the actual case records to be of value.—*H. M. Childress, M.D., Charleston, South Carolina.*

COMPOUND FRACTURES. Harry C. Blair. *Northwest Medicine*, XLI, 23, January 1942.

The author advocates four principles in handling compound fractures.

1. Débridement, in which the tissues with a diminished blood supply are removed with a sharp knife or scissors. No antiseptic is placed in the wound, but, if dirt is present, it may be washed with green soap for fifteen minutes. Great care should be exercised to avoid trauma to the tissues. No sutures are placed within the wound. Sulfanilamide or sulfathiazole is implanted.

2. The skin is closed.

3. The fracture is reduced, usually by pins which are incorporated in a plaster cast.

4. The wound is exposed by cutting and removing all padding and gauze. A fine-meshed wire netting is placed over the window.

The author places considerable stress on exposure of the wound, and on allowing the extruded serum to form a coagulum over the wound. Ten days or a fortnight should elapse before any correction for deformity is made, and complete rest for the limb should be stressed during this period.—*Charles Lyle Hawk, M.D., Los Angeles, California.*

TUBERCULOSIS OF THE KNEE IN ADULTS. H. J. Wyckoff. *Northwest Medicine*, XLI, 120, April 1942.

The author uses Steinmann pins to fix the joint within the cast after a fusion operation. This rigidly immobilizes the limb and hastens the healing, besides giving greater comfort to the patient.—*Charles Lyle Hawk, M.D., Los Angeles, California.*

SCIATICA FROM ANEURYSM OF SCIATIC ARTERY. John F. LeCocq. *Northwest Medicine*, XLI, 121, April 1942.

The author reports one case of this rare condition. The patient had injured his lower back, in heavy lifting, fifty-three years previously, and had had more or less distress ever since. In July 1941, while picking strawberries, he developed a more severe pain in the lower back, centering in the right buttock. Examination revealed a visual pulsation and audible bruit in the right gluteus maximus. Operation revealed an aneurismal sac the size of a small orange entangling the trunks of the sciatic nerve. It was removed and the results were satisfactory.—*Charles Lyle Hawk, M.D., Los Angeles, California.*

THREE C'S OF SURGICAL HEALING. Edwin A. Nixon. *Northwest Medicine*, XLI, 129, April 1942.

The author's three C's are for vitamin C, cotton thread for sutures, and cellophane. He elucidates the functions of vitamin C in wound healing, and gives the advantages of cotton thread for suture material. He believes it causes less tissue reaction, is better adapted to contaminated tissues, is less likely to cause sinus formation, and shortens healing time. He uses black or white thread numbers thirty to sixty. He uses cellophane to cover the wound, thus making it, at all times, visible for inspection.—*Charles Lyle Hawk, M.D., Los Angeles, California.*

THE USE OF VITALLIUM IN SURGERY WITH SPECIAL REFERENCE TO CUP ARTHROPLASTY. W. H. Cole. *Proceedings of the Royal Society of Medicine*, XXXIV, 779 (Section of Orthopaedics p. 29), 1941.

The author discusses the use of various metals prior to the development of vitallium, and feels that the latter is the most "silent" of all. He describes his findings in two cases in which he was able to examine the femoral heads six months and one month after cup arthroplasty had been done. In the first case the cup split six months after surgery when the patient was up and about with an excellently functioning hip. In the other, where no weight-bearing and very little motion had taken place, the patient died one month postoperatively. No cartilage replacement was noted as contrasted to the findings reported by Smith-Petersen in two patients, twenty-one and twenty-five months postoperatively. In the author's first case the cup had to be pried from the head. However, on removal of the cup, the head was excellently molded, smooth, and glistening, as was the acetabulum. Microscopically the head and acetabulum were lined with fibrous tissue. In the second case, the cup was loose and the stump of the neck (the head had been necrotic and therefore removed) was rounded and smooth, with irregular islands of what appeared to be cartilage but histologically revealed organizing fibrous tissue.

The author feels that removal of the cup two to three years postoperatively might result in a better hip. He also suggests that the cup fit loosely over the neck, so that motion may take place beneath it as well as between it and the acetabulum, in order to better form a new weight-bearing surface.

In postoperative treatment, the author places the extremity in balanced traction immediately following surgery, and a little swinging motion is attempted the very next day. This motion is increased gradually, and after two weeks is assisted by passive swinging, abduction, and adduction. A stationary bicycle is very worth while prior to weight-bearing, which can be started in five to eight weeks, if the bone in the femoral neck is not too cystic or atrophied. The author strongly advises against forcing too much motion at the start. He believes this should develop by continuous exercise and use. He also mentions the fact—and cites several cases—that these arthroplasties are remarkably free of pain on motion, despite previous arthritic involvement of the operated hip.—*S. M. Albert, M.D., Iowa City, Iowa.*

ACHONDROPLASIA FOETALIS (CHONDRODYSTROPHIA FOETALIS). E. L. Jenkinson and R. E. Kinzer. *Radiology*, XXXVII, 581, 1941.

Achondroplasia is defective evolution, in the process of endochondral ossification, evidenced at a very early period of intra-uterine life. The disease often is familial, with preponderance among females. The patients frequently have a large head vertex, pug nose, and blue sclerae. The trunk is of normal length; the extremities thick and short. The hands are broad and the fingers divided into three groups, divergent at the ends, the "trident hand". The adult achondroplastic dwarf is usually under four feet in height. The condition should be distinguished from hereditary deforming chondrodysplasia, the former developing prenatally and often proving fatal, while the latter develops in childhood and seldom affects the span of life. Moreover, achondroplasia affects only the epiphyseal cartilages, while the exostoses of chondrodysplasia arise from the diaphyseal side and extend in the direction of the muscle pull. Microscopically, the cartilage cells in achondroplasia are large, not arranged in rows, and tend to grow in all directions, while in the cartilagenous exostoses their arrangement is orderly.

The cause of achondroplasia is not known. The condition apparently is inherited, and in the mendelian order.

The rare condition described by Morquio as "Chondro-osteo-dystrophy" also produces a dwarfed skeleton, with irregularities of ossification at the metaphyses.

Five new cases of achondroplasia, four of them in negroes, are described and illustrated.—*Edward N. Reed, M.D., Santa Monica, California.*

CALCIFICATION AND OSSIFICATION OF VERTEBRAL LIGAMENTS (SPONDYLITIS OSSIFICANS LIGAMENTOSA): ROENTGEN STUDY OF PATHOGENESIS AND CLINICAL SIGNIFICANCE. Albert Oppenheimer. *Radiology*, XXXVIII, 160, February 1942.

The pathogenesis of this condition is disputable. The longitudinal ligaments are often calcified or ossified in the presence of vertebral infections,—such as tuberculous typhoid, staphylococcic osteitis, syphilis, and Malta fever; after trauma; and, less commonly, around malignant metastases. It may be present in juvenile and in senile kyphosis.

Bone hypertrophy always follows rarefaction. When vertebrae adjacent to a thinned disc are constantly injured mechanically, because of the loss of thickness and elasticity of their natural buffer, traumatic rarefaction results,—a reaction corresponding to callus formation. A triangular area between the anterior vertebral edge, the attachment of the longitudinal ligament to the body above this edge, and to the disc below, presents a vertebral surface devoid of ligamentary covering. It is in this space that vertebral osteophytes form. Instead of playing an active part in the formation of osteophytes, the vertebral ligaments mold them and set a limit to their growth.

The longitudinal ligaments may be calcified or ossified in the absence of other vertebral lesions. This tends to occur where the ligament is relaxed, as opposite a reduced intervertebral space or on the concave side of a kyphosis or scoliosis. Calcification and ossification of vertebral ligaments are not typical of any disease, and should not be confused with arthritis. In their presence, vertebral mobility is normal, unless there is also present disease of the apophyseal joints or vertebral bodies. Complete spinal rigidity has been observed in Marie-Strümpell disease, in the entire absence of calcification or ossification of ligaments. This condition does not cause pain. It is not a pathological or a clinical entity, but a secondary reaction, often indicating the coexistence of a lesion of the vertebral bones or joints.—*Edward N. Reed, M.D., Santa Monica, California.*

MARCH FRACTURE. George R. Krause. *Radiology*, XXXVIII, 473, April 1942.

The term is applied to fracture of a metatarsal occurring in persons who have experienced prolonged and repeated foot strain, but have not suffered a single obviously severe injury. The pathogenesis is not clearly understood. These fractures are the

result of repeated subthreshold mechanical insults, acting by summation to a point beyond the capacity of the bone to bear stress. The onset is usually gradual, but may be abrupt. There is discomfort in the metatarsal area, at first slight, but increasing, and manifest only on weight-bearing. Technically perfect roentgenograms, showing maximum detail, and in anteroposterior and oblique projections, are necessary to make an early diagnosis. The fracture line is often difficult to demonstrate, and films made during the first ten days may show no pathological changes. There is no displacement, and the fracture is often incomplete. In from one to three weeks, a fuzzy spindle of callus appears around the shaft of the second or third metatarsal, at which time the fracture line usually becomes visible. In another three to six weeks the callus becomes less bulky and more sharply defined. Several months later the only remaining sign is slight thickening of the cortex.

Differentiation must be made from osteogenic sarcoma and from Ewing's tumor, usually by the history and the roentgenographic changes during the first three weeks. The treatment is by immobilization for three to six weeks, followed by physiotherapy. Ten cases are reported.—*Edward N. Reed, M.D., Santa Monica, California.*

CINEMATIZACIÓN DEL MUÑÓN DE AMPUTACIÓN (Cinematization of Amputation Stump).

Francisco García Díaz. *Revista Española de Medicina y Cirugía de Guerra*, IV, 1, 1941.

Work in the field of the cineplastic stump was stimulated by the modern perfection of prostheses. At best, however, a mechanical hand is insensitive, and only one to three motor levers can be used, for humans do not possess individual action of the muscles of the stump. The history of the development of prostheses is given.

Siegel in 1929 studied 539 patients with cineplastic stumps. In 68.7 per cent., a Sauerbruch prosthesis was worn; in 21.3 per cent., no prosthesis was worn, because of discomfort, neuromata in the cineplastic canal, or vague complaints of discomfort or inutility of the appliance; and in 10 per cent., a prosthesis was worn, but the stump was not cinematized. Of the 68.7 per cent. wearing a prosthesis, 68 per cent. estimated their capacity for work at almost 100 per cent., and only 13 per cent. had as little as 50 per cent. use of the arm.

Trendel in 1933 studied thirty cases with a ten-year follow-up. Of the twenty-one cineplastic stumps of the upper arm, nine were good, and twelve poor; of the nine stumps of the lower arm, four were good, and five questionable. He concluded that the formation of a cineplastic stump is the operation of choice for double-arm amputations. In single amputations in a laborer, a "working stump" is probably preferable, but a business or professional man may make good use of a cineplastic stump.

Modern techniques for cineplastic amputations, depending upon the site of the amputation, include:

1. Phalangization of the first metacarpal,
2. Claw procedure used by Krukenberg,
3. Canalization recommended by Sauerbruch and Pellegrini.

The author has had six cases in which he has used some one of these procedures. The results of phalangization of the first metacarpal in two cases were excellent. Krukenberg's pincer, which affords an excellent amputation stump, was used in one case. The rotary type of prosthesis (Delisch) is the most satisfactory. Sauerbruch's canalization was used in three cases,—one in the lower forearm, one in the upper forearm, and the other in the upper arm.

It is a debatable question whether, in forearm amputations of the lower third, cinematization is better than a Krukenberg's stump. The amputation stump is first revised, so that the extensor and flexor tendons are freed from bone and joined to each other over the stump. Six weeks later canalization is done, using both volar and dorsal muscle flaps. These work as antagonists and protagonists, and give strength and refinement to movements of the prosthesis. A rotary type of prosthesis is best.

For upper forearm stumps, two extrasegmental motor levers are fashioned,—one in the biceps and the other in the triceps. The biceps insertion is cut, and a portion of the triceps is freed entirely from the lateral extensors. Elbow movements are entrusted to the brachialis for flexion, and to the lateral extensors for extension. The biceps flap closes the hand, the triceps opens it. If the stump is very short, it may demand fashioning to receive the prosthesis. Long periods of training are required to develop refinement in the control of these flaps.

For amputation in the upper arm, the author used only a biceps flap to close the hand, and a spring to open it. This was his first case, and only one motor element was used, so as to simplify the prosthesis. The elbow was flexed by flexing the stump. Rotation was controlled mechanically by the prosthesis.

The author emphasized that, in time, a patient with an upper-arm prosthesis develops a muscle sense and sight which enables him to "sensitize" the prosthesis.—*Víctor Richards, M.D., San Francisco, California.*

EL PIE PLANO POR INSUFICIENCIA EN LOS HERIDOS DE GUERRA (Flat-Foot from Insufficiency after War Wounds). Manuel Cardenas. *Revista Española de Medicina y Cirugía de Guerra*, IV, No. 33, p. 257, 1941.

Flat-foot after war wounds of the foot is seen most commonly under three conditions:

1. After large wounds of the osseous system;
2. In the good leg after amputation of the injured extremity;
3. In both feet after wounds in a single foot.

In all of these groups, the etiology is an excessive load on an arch insufficient from inactivity, atrophy, or nerve or vascular lesions of the extremity. There are four fundamental pathological features of flat-foot:

1. Displacement of the bones of the foot,—abduction of the os calcis, flexion of the talus, dropping of the proximal ends of the metatarsals, cuboid, and cuneiforms, and supination of the forefoot with spreading of the toes;

2. Deformity of the bones,—thinning and erosion at the abnormal points of contact, and exostoses and enlargement where no pressure exists;

3. Articular lesions,—deforming arthritis;

4. Lesions of the soft parts,—stretching and relaxation.

After any injury to the foot, attempts should be made to prevent the initial insufficiency of the arch by giving calcium and vitamin D by mouth, by massage and physiotherapy of the foot, circulatory exercises, and muscle exercises. Foot pads and plates are permissible if used with caution. Once an insufficiency of the arch has occurred, subsequent deformity will ensue, and surgery will then be necessary. The author feels that the Young operation is best for these cases. This operation consists in drilling a hole through the navicular, and rerouting the course of the anterior tibial tendon so that it passes through this tunnel. It serves three distinct purposes:

1. It elevates the internal longitudinal arch;

2. It suppresses the normal fanning action of the tendon on the metatarsal arch;

3. It approximates the plantar surfaces of the mid-tarsal and metatarsotarsal joints, thereby spreading their dorsal surfaces.

Care must be taken in performing the operation to prevent a luxation of the tendon from the navicular tunnel. The author does not like any other soft-tissue operation, and reserves osseous procedures (triple arthrodesis and wedge osteotomy) for late, severe, and intractable cases.—*Victor Richards, M.D., San Francisco, California.*

HERIDAS DE GUERRA DE LA ARTICULACIÓN DE LA RODILLA (War Wounds of the Knee Joint). M. García Portela. *Revista Española de Medicina y Cirugía de Guerra*, IV, No. 29, p. 35, 1941.

The author reports on his experience with twelve cases. Injuries of the knee are the most frequent of all joint injuries, occurring in 1.86 per cent. of all war wounds. Diagnosis of penetration of the knee joint is made if:

1. Entrance and exit wounds obviously involve the joint;
2. Hemarthrosis is present;
3. Synovial membrane protrudes from the wound;
4. Normal saline, injected aseptically into the knee joint, runs out of the wound;
5. Roentgenograms disclose an intra-articular bone lesion.

The mortality rate from compound injuries of the knee was 84 per cent. in the Civil War, 10 to 20 per cent. in World War I, and probably less in the Spanish War because of earlier treatment of the injured. If these wounds can be treated within eight to nine hours of injury, open operation, with careful débridement and removal of all foreign bodies should be performed, and the joint immobilized in the position of optimum function. The author describes in detail the early and late treatment of these wounds.

Early treatment, usually under eight to ten hours, is given as follows:

1. For trauma limited to the soft parts, the entrance and exit wounds are excised down to the joint cavity, all clots, bloody discharge, and foreign bodies are removed, and the wound is sutured in layers without drainage. For larger wounds with more extensive tissue damage, the author débrides the wounds of entry and exit, and then does a clean arthrotomy of the knee to remove foreign bodies, bullets, and clots from it. He prefers a clean arthrotomy of the knee to enlarging the wound of entry. The arthrotomy wound is closed *per primam*, as are usually the débrided wounds.

2. Lesions of soft parts and discrete osseous lesions, particularly of the patella, are treated by arthrotomy with débridement of all dead and devitalized tissue. Since extensive comminution of the patella is usually present, suturing the peripatellar tissues with slowly absorbed catgut should be done rather than by encircling the patella with wire. The joint is irrigated with saline, Rivanol or Chlumsky solution. Articular drains are not advised, but small gauze drains may be placed in soft tissues outside of the sutured capsule for forty-eight hours, if infection is suspected. Plaster immobilization with elevation of the limb is strongly recommended.

3. For knee wounds with bone lesions of the femur or tibia, when articular function is undoubtedly lost, primary resection of the joint is indicated. The removal of more than a total of six centimeters of bone is not advised, because an unstable fusion with marked shortening will result. Occasionally a clean fracture of a femoral condyle can be replaced and held with a screw. If vascular and nerve lesions are also present, and conservative treatment seems futile, immediate amputation should be done.

Late treatment, after twenty-four to thirty-six hours, is as follows:

If only the soft parts are involved, or if the joint function may be restored, the injury is treated conservatively and watched carefully for infection. If infection occurs, and is of a benign type (anterior compartment), it may be treated by repeated aspirations, irrigation with saline, Rivanol, or Chlumsky solution, or by simple anterior arthrotomy of the joint. If posterior extension or capsular phlegmon appears, resection of the joint provides the best drainage; it sacrifices the joint, but saves life and limb. After resection, the quadriceps pouch must be completely opened and the joint held acutely flexed to permit adequate drainage. Later the joint is placed in the position of optimum function and is immobilized. Amputation is done as a life-saving procedure.—*Victor Richards, M.D., San Francisco, California.*

CALCIFICACIONES SUBDELTOIDEAS (Subdeltoid Calcifications). Oscar R. Marottoli and Arnoldo Didier. *La Revista de Medicina y Ciencias Afines*, III, 495, 1941.

This paper is based on clinical experience with a number of cases treated during the last few years, in which the pathology was a calcification in the tendon of the supraspinatus. This condition is a part of periarthritis of the shoulder, and is synonymous with subdeltoid calcification. The condition comes on in various ways and the symptoms vary with the pathogenesis. Various theories have been suggested as to the etiology of the disease, and these are discussed, with references to the literature given. The cause is still uncertain although trauma probably plays an important part. The characteristic

roentgenographic findings are given together with the technique for obtaining roentgenograms of the area. The treatment varies with the stage of the condition and the symptoms, so that no universal method of treatment can be used. Radiotherapy is sometimes useful and the technique is outlined. Surgical treatment in the form of exploration of the subdeltoid bursa with removal of the calcified mass from the supraspinatus tendon is frequently done, using the technique described by Carnett. The authors present a series of seven cases of their own in some detail. One patient was treated with heat, and made a complete recovery; one, with novocain injection, and recovered; and two, with roentgenotherapy, but received little or no relief. These two patients were then operated upon for the removal of the calcium deposit, and made a satisfactory recovery.—*Louis W. Breck, M.D., El Paso, Texas.*

SOBRE UN CASO DE OSTEOMIELITIS DE LA DIAFISIS FEMORAL EN APARIENCIA PRIMITIVA (Report of a Case of Typhoid in Which the First Manifestation Was in the Femoral Diaphysis). R. A. Marotta y Fernando M. Bustos. *La Revista de Medicina y Ciencias Afines*, III, 644, 1941.

The authors quote Keen who reported a series of forty-seven cases of typhoid osteomyelitis, ten of which developed in the first two weeks of the disease. More often the osteomyelitis may develop much later in the course of the disease, and the authors mention a case of theirs in which the osseous lesion developed twenty-eight years after the intestinal typhoid. They believe that Furbringer was right in stating that the osseous lesion may precede the intestinal symptoms. It is possible that in these cases the patient may have the so-called ambulant type of typhoid, and it may not be recognized. The authors report a case of their own in great detail.

The patient, a boy of nineteen, had not been feeling well for a period of eight days before the infected area was drained and pus was obtained. His other signs and symptoms consisted of lassitude, fever, and splenomegaly. Tests showed: a Widal positive, one to 800; negative blood culture; and negative Wassermann. A roentgenogram of the femur showed a localized osteomyelitis. The patient was given prontosil without improvement. He was later given typhoid vaccine subcutaneously and intravenously, and made a recovery, the temperature coming down by lysis.—*Louis W. Breck, M.D., El Paso, Texas.*

FRACTURES OF THE ASTRAGALUS. Harold B. Boyd and Robert A. Knight. *Southern Medical Journal*, XXXV, 160, February 1942.

This is a report of fifty-eight cases of fracture of the astragalus treated by the staff of the Campbell Clinic in Memphis, Tennessee. The hazard of aseptic necrosis must be borne in mind in the treatment of these cases. Very accurate reduction is required in the treatment of these cases because of the many articular surfaces which must be accurately replaced. Open reduction is usually necessary, and internal fixation is often required to maintain the reduction. Subastragalar and astragalonavicular arthrodesis may be necessary. The fractures of the astragalus are classified, and appropriate treatment is described for each. Malunited or poorly reduced fractures require arthrodesis of one or more joints. Astragalectomy is reserved for very severe cases or compound infected fractures.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

MADELUNG'S DEFORMITY (Case Report). J. Marsh Frere. *Southern Medical Journal* XXXV, 168, February 1942.

Only one case of Madelung's deformity was seen in more than 1200 fractures x-rayed at the Newell and Newell Clinic in Chattanooga, Tennessee. This deformity is due to idiopathic disturbances of the growth of the epiphysis of the lower radius, which cause deformity of the wrist, and apparent anterior subluxation of the hand. The

etiology is not known. Some think that trauma plays a part, others attribute it to endocrine disturbances. The ulna is not affected and as it continues to grow its lower end becomes prominent on the back of the wrist. The condition occurs four times more frequently in females than in males, and is usually first observed between the ages of ten and fourteen years. Heredity seems to play a part. Symptoms are pain, deformity, and limited motion of the wrist. Roentgenograms confirm the diagnosis. A typical case is reported with a review of the recent literature.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

TRANSPLANTS TO THE THUMB TO RESTORE FUNCTION OF OPPOSITION: END RESULTS.

C. E. Irwin. *Southern Medical Journal*, XXXV, 257, March 1942.

Lack of opposition power in the thumb is a serious handicap to the usefulness of the hand. The grasping ability of the hand is decreased to the extent that its function is hardly more than a hook, and the finer movements of the hand are lost. The various movements of the thumb are discussed. Following an attack of infantile paralysis, many of these movements may be lost. A basic transplant to restore the usefulness of the thumb includes the following features:

1. The course of the transplanted tendon from the muscle belly to the pulley must be in a straight line.
2. The pulley must be so constructed that its original position will remain constant
3. The pulley must be so constructed that it will allow free gliding movement of the tendon.
4. The tendon must lie in front of or toward the flexor side of the metacarpophalangeal joint as it passes to its insertion in the base of the proximal phalanx.
5. The tendon is fastened directly to the bone, entering the proximal phalanx of the thumb on the border adjacent to the web.

The details of the mechanical advantages of this transplant are described. The flexor sublimis tendon to the fourth finger is passed through a tendinous pulley, formed at the pisiform bone by a part of the flexor carpi ulnaris, is extended subcutaneously, and is attached to a tunnel in the second phalanx of the thumb. Contra-indications and postoperative treatment are discussed. The results obtained were good, twelve; fair, four; and poor, three.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

PALLIATIVE TREATMENT OF IRREDUCIBLE CONGENITAL DISLOCATIONS OF THE HIP.

Charles J. Frankel. *Southern Medical Journal*, XXXV, 404, April 1942.

The methods used by various clinics in the treatment of this condition are: (1) shelving, (2) osteotomies, (3) anterior transposition, (4) no operative treatment, but the use of built-up shoes, and (5) a combination of these procedures.

It is reported that the results in 78 per cent. of the patients who had shelf operations were satisfactory.

The advantages claimed for osteotomy were: (1) safety and simplicity, (2) improved stability, (3) diminished lordosis, and (4) freedom from pain and fatigue.

One method, employed only in selected unilateral cases, has been used with some success to eliminate pain and fatigue. It consisted in preliminary traction to pull the head down, then arthrodesis by means of a bone graft driven into the neck and shaft of the femur at the distal end and into a trap door above in the ilium.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

THE NICOLA OPERATION FOR RECURRENT DISLOCATION OF THE SHOULDER. A REVIEW OF TWENTY-SIX CASES. R. Beverly Raney and Oscar L. Miller. *Southern Medical Journal*, XXXV, 529, May 1942.

This is a report on twenty-six cases in which the Nicola operation was performed on one shoulder. There were twenty-four males and two females. The average age

was twenty-one years. Eighteen cases were due to athletic injuries; three, to severe trauma; and five, to epileptic convulsions. The average period of time between the first dislocation and the operation was two years. Of this series of twenty-six operations, one or more redislocations after the operation developed in nine patients. Details of the cases of redislocation are given. But even these patients report very little discomfort or inconvenience, and are less disabled than before the operation. None of these patients has had a second operation. Some technical details to prevent recurrence of the dislocation are listed.—*Fred G. Hodqson, M.D., Atlanta, Georgia.*

A CRITICAL SURVEY OF TEN YEARS' EXPERIENCE WITH FRACTURES OF THE NECK OF THE FEMUR. Mather Cleveland. *Surgery, Gynecology and Obstetrics*, LXXIV, 529, February 16, 1942.

The author analyzes the results obtained in the treatment of 110 fractures of the neck of the femur at St. Luke's Hospital from 1930 to 1940. The first fifty, already reported, are included for the sake of contrast.

Smith-Petersen's method of open reduction and internal fixation was used in fourteen cases, with very little improvement in end-results over those obtained by non-operative means. Of the seven patients whose fractures united, results in only two were wholly satisfactory. There were three cases of extensive aseptic necrosis, and two of severe malunion with marked deformity.

Undisplaced fractures of the neck of the femur, treated by three to four weeks' rest in bed and weight-bearing after the application of a Thomas caliper brace, gave invariably optimum results. A number of undisplaced fractures have been nailed without reduction.

Accurate closed reduction by manipulation and the careful insertion of a three-phanged nail has yielded surprisingly good results; union of the fracture occurred in 86 per cent. of the survivors.

When circulatory disturbance occurred in the femoral head, it always appeared within the first year after the fracture. Seventy-five per cent. of the patients with non-union of the fractures had extensive circulatory disturbance in the femoral head. Of those subjected to open reduction, whose fractures had united, 42.8 per cent. showed extensive aseptic necrosis of the femoral head. Of the twenty-seven patients with united fractures, who had been treated by closed reduction and nailing, 18.5 per cent. showed some evidence of circulatory disturbance, for the most part very mild. The majority of all patients showing circulatory disturbance in the femoral head, whose fractures had united, had had an inadequate reduction of the fracture.

From experience with the last sixty patients, the author found that the most important single factor in securing union and avoiding circulatory disturbance in the femoral head was adequate reduction of the fracture. The actual or so-called migration of the nail is usually due to failure to properly reduce the fracture, and occurs almost exclusively in ununited fractures.

TUBERCULOSIS OF THE LONG BONES. THE IMPORTANCE OF ITS DIFFERENTIAL DIAGNOSIS FROM PYOGENIC OSTEOMYELITIS. Merrill Coleman Mensor. *The Western Journal of Surgery, Obstetrics and Gynecology*, L, 187, April 1942.

The author reports a case of multiple pyogenic osteomyelitis of the long bones in an adult, which proved to be of tuberculous origin. The similarity of this type of bone tuberculosis to that of the "common garden variety" of osteomyelitis and the importance of a differential diagnosis is stressed, as early diagnosis is essential for a good prognosis. It is a disease of adult life and not of childhood. Treatment should consist of saucerization and closure, followed by plaster-of-Paris immobilization,—particular care being taken to avoid secondary infection. The prognosis is always poor if metastases are present.—*F. Harold Downing, M.D., Fresno, California.*

The Journal of Bone and Joint Surgery

WOUNDS IN MODERN WAR *

BY COL. J. A. McFARLANE, R.C.A.M.C., TORONTO, ONTARIO, CANADA

Surgical Consultant to the Canadian Active Service Force

It is a great honor and privilege to address this Association but it is also a heavy responsibility. Though I may bring you little that is new. I speak for an enthusiastic contingent of Canadian surgeons who for two and a half years have devoted much time and thought to the practice of military surgery. I know that in extending an invitation to me you are doing honor to that group.

When we went to war in September 1939, many of us thought in terms of 1918. It was only natural that we should; for twenty years we had put fighting and its problems from our minds. It is not altogether an advantage to a nation to have a background of war at twenty years' distance when it faces another struggle. In every branch of the service, men recalled the campaigns of France, of Gallipoli, of Arabia. It may be that we shall be best served when we rid ourselves of the traditions of those years. Two decades between wars is a tragic interval. It is short enough to maintain continuity of thought and memory of past experience; it is too long amid the false security of peace for serious contemplation of the inevitable advances of military strategy that occur in the war-minded nation. Experience gained in the last war, unless it is subject to revision and development, may be a handicap rather than an advantage under these circumstances. There is needed not only the inflexible determination of purpose—perhaps more commonly the attribute of middle age—but also the elasticity of mind, the fashioning of new tools, and the adroit adaptation to new methods—surely the qualities of youth. This is a young man's war.

The management of wounds presents the same problems today as it

* Read at the Annual Meeting of The American Orthopaedic Association, Baltimore, Maryland, June 4, 1942.

has through the generations of military surgery,—the treatment of shock and hemorrhage and the prevention of infection. Down through the years, the question of transportation of the wounded has become increasingly difficult, and much time and effort have been spent on the problem of getting the wounded man to the surgeon. With the advent of *Blitzkrieg* it became well-nigh impossible to get the wounded back to the surgeon at any organized hospital, except with the aid of air ambulances. There is no doubt that this method of transportation is ideal. Two essentials are necessary, however. Air ambulances are relatively slow and, therefore, very vulnerable to fighter attack, so that well-protected landing fields must be found in the vicinity of the battlefield, and the force using them must have superiority in the air. In a fast-moving campaign it is unlikely that both of these essentials will be available. The distances covered by mobile fighting columns in modern war may take them in one day completely out of reach of casualty clearing stations or evacuation centers which are organized on the 1918 model. Moreover, the terrain and roads leading back from the front may well be blocked by the stream of upgoing traffic in guns, rations, reinforcements, ammunition, and petrol. It is obvious, then, that the surgeon must be brought forward to the rear of the battle area if that early treatment which is essential to saving life and limb is to be provided.

THE MOBILE SURGICAL UNIT

Mobile warfare has presented a new problem to the surgeon; he must put himself, his assistants, and the essentials of equipment into vehicles which can move as quickly as the armored divisions which he serves. He must be prepared to set up his theater in whatever shelter he can find, and to do it quickly. He must be able to disband it rapidly and to move forward to another area on short notice; unfortunately, sometimes he must be ready to move it rearward out of enemy hands when the battle sways against his comrades. Neither the British nor the Canadian Armies had a unit in the beginning of the war which fitted into such a scheme. The field ambulances had been mechanized, but they lacked operating equipment. Their duties were those of collecting and evacuating. The casualty clearing station was the first organized operating center, and it lacked the necessary mobility.

In the East African and Libyan campaigns the personnel of the field ambulances found themselves faced with the responsibility of forward operating units, and often with limited equipment. As a sequel to this, mobile operating teams were formed at army headquarters. The personnel consisted of two surgeons, sometimes an anaesthetist, and two or three theater orderlies. Their equipment was carried in two lorries, and they frequently set up their post at the main dressing station of a field ambulance.

The Canadian Army has in the past few months authorized the for-

mation of certain mobile surgical units, with arrangements for adding others as needed. These, in short, consist of three trucks: one three-ton lorry, fitted with light generating apparatus, water tank, and compartments to hold operating equipment and supplies; another thirty-hundred-weight truck with a penthouse, which carries baggage, blankets, and emergency rations; and, finally, a station wagon for the personnel. The personnel consists of two surgeons, one anaesthetist, two orderlies, and two sisters; the latter are to be allowed to go with the unit at the discretion of the Deputy Director of Medical Services of the Corps, and depending on the exigencies of the situation. If sisters do not accompany the team, their places are taken by two extra orderlies. Such a unit can be in a position to operate within half an hour of arrival and the securing of some sort of shelter. It carries sufficient sterile linen for from thirty to forty operations, blood substitutes, plaster-of-Paris, and operating equipment for general traumatic surgery. The author is convinced that something of this sort is the answer to the problem of providing early surgery for the wounded in this war.

The surgeon who works in such a mobile surgical team should be young and physically fit. He should be well trained in the surgery of trauma,—not merely trauma of the chest, or of the abdomen, or of extremities, but that of any part of the body. In the modern campaign there is no time to segregate special types of cases in the forward area. The surgeon in the mobile unit must be trained to handle quickly and efficiently the results of violent trauma of any part of the body. He and his associates must have practised working as a closely knit, efficient team.

In the forward area, there is little place for the specialist, unless he is a general surgeon with special knowledge. The serious problem is the treatment of multiple injuries,—an open fracture of an extremity plus a head wound; a fracture of the pelvis and a rupture of the urethra; a penetrating wound of the chest or abdomen and burns about the face and hands. The surgeon faced with these problems must be versatile, resourceful, and, above all, he must be able to estimate with despatch the most urgent cases, and to act quickly and skillfully. He should be able to recognize those patients who are beyond human aid, give them sedatives, and leave them, without the waste of valuable time which should be utilized for the saving of life and limb.

TREATMENT OF SHOCK

Shock, with or without gross blood loss, remains a first consideration in the treatment of wounds. Perhaps the greatest advance in the treatment of shock has resulted from the recognition that serum or plasma has all the necessary constituents to combat its effects. Serum, either in its concentrated form or in its powdered state, has the very great advantage of being easily transportable. It can be stored for long periods under varying climatic conditions. Plasma has the same constituents as serum,

plus fibrinogen and an anticoagulant. In its fluid form, it will not keep as long as serum. This is due partly to the fact that, in England at least, it has been prepared as a by-product of blood banks and usually not from fresh blood, but from those containers of bank blood which it is unwise to keep longer for administration as such.

In England, the civilian, naval, air force, and army organizations work in close association, using supplies from common sources. With an expeditionary army there is a formation known as a forward or intermediate transfusion depot, which carries supplies of donor blood and blood substitutes. The blood substitutes are shipped from the home base in Britain. In distant fields donor blood may be prepared in limited quantities in the area. With each casualty clearing station there is a transfusion or resuscitation officer who is skilled in the use of all these measures and who, with his truck, acts as a forward distributing center, as well as a supervisor of shock treatment. The mobile operating unit, however, has to be self-sufficient in this respect, and carries enough plasma and serum for from thirty to forty cases, and possibly the means for doing whole-blood transfusions from personnel in the area. The field ambulances also carry a supply of blood substitutes and a transfusion box with giving sets. B.L.B. oxygen masks and containers are supplied to field ambulances and the casualty clearing station. Every effort has been made to provide the means for treating shock as far forward as possible. There is no doubt that it has been of the greatest value. In England during the severe raids, large supplies of whole blood and plasma were used. Our experience was with supplies from the transfusion depots in our own areas. We concluded that, in those cases without great blood loss, plasma or serum is just as effective to combat shock as is whole blood. Our experience with serum was largely with the concentrated form rather than with the dried product. We felt that the latter, of which we had limited quantities, should be kept for severe emergencies such as invasion. In a limited number of cases, dried serum, properly reconstituted, seemed just as valuable as plasma.

The diagnosis of shock has been made on clinical grounds with lowering of the systolic blood pressure as the most important single guide as to its degree. Repeated hemoglobin estimations have for the most part been used as the measure of hemoconcentration. Hematocrit readings have presented some difficulties, because it is not always convenient in times of stress in a war hospital to have the routine estimations carried out when indicated.

Whole blood, usually bank blood, has been reserved for those cases in which there is severe loss of blood. In the Canadian military organization, with such available facilities, it is felt that shock can be, and is being treated with a fair amount of success. With such adequate measures ^{of} resuscitation, the surgeon is called upon to treat many more complicated injuries which, without such advantages, would

The author had occasion to see, in March 1942, a patient who was wounded in 1918, and to review certain points of interest in his history.

The patient, an Englishman, was wounded by a shell fragment in the right buttock. The bone was not involved. Roentgenograms revealed no evidence of old injury or of infection. There was no indication of a sciatic-nerve lesion. The wound, therefore, involved only the soft tissues of the buttock, including the glutei. The patient reached a casualty clearing station some twelve hours after injury, and was operated upon. He was subsequently transferred to a large hospital in France, where he remained for six months. One or two drainage operations were performed during that interval. Dressings were changed three times a day, and the wound was "syringed". Following discharge from the hospital he attended an out-patient department for another six months. A very good result was obtained, and the patient is now a corporal in the Provost Corps in the Canadian Army.

It is interesting to contrast this case with that of a patient injured in the great air raid on Coventry, who suffered a bomb wound in exactly the same area and approximately of the same degree.

The patient's wound was explored, foreign bodies were removed, and a thorough débridement was carried out. He was then put in a plaster spica. He was in the hospital two months, during which time he had in all three changes of plaster and dressing. At the end of the third month he was able to return to his work in the factory.

The saving of time (the time of skilled labor is precious in England), the saving of material (gauze, wool, and bandages), and the saving in pain and discomfort to the patient hardly need comment. Our surgeons working in Coventry found that there was still a tendency at the emergency centers to close wounds. Those reaching them with sutures were all reopened, thoroughly explored and treated in a manner similar to the case illustrated.

Infection

In the last war, it was customary to redress wounds at various stages during the long and arduous journey from the regimental aid post to the base hospital,—in the field ambulance, perhaps first at their advance station, then at the main station, the casualty clearing station, the ambulance train, and finally at the base hospital.

The closer to the base, the greater was the prevalence of hemolytic streptococci found in the wounds. Hare and others have shown that this organism finds its way into wounds, not from the skin of the patient, but from the ministrations of the attendants and dressers; from the air of the dressing stations and hospitals, where other infected wounds are being continually tended; from the soiled dressings which, even with the greatest care, distribute organisms throughout the air; from the blankets which cover such patients; from the dust which, in spite of precautions, is stirred by the inevitable movement in a busy ward.

Efforts are being made in England to combat this dustborne infection. Greater care is encouraged in dressing technique. In some hospitals the floors are treated with spindle oil in an effort to trap the dust. A method of treating blankets with minimal amounts of oil has been recommended, with the idea of lessening the danger of airborne infection.

It is universally agreed that the removal of dead muscle is the best prophylactic against gas gangrene, even in the light of work recently published on various chemical compounds used as local preventives. Surely then, in the light of these facts, a treatment which provides adequate prophylaxis against gas infection, admits of complete rest and support, necessitates few dressings, and, therefore, minimizes the possibility of airborne infection, is a rational method. Our experience supports that conclusion.

When we came abroad, some of our colleagues in Canada were most anxious that clinical investigation should be undertaken, by which we might determine the relative value of the irrigation treatment and the closed-plaster method. That has not been done. If our troops had been engaged in active fighting earlier in the war, as we certainly expected they would be, such an investigation might have been practical.

We began to adopt the closed-plaster treatment in the severe cases of wounds and compound fractures, and were so impressed by the results that the practice of irrigation and repeated dressings has now almost disappeared from all our military hospitals. The dressing carriage is no longer a very important vehicle. Large and difficult dressings are done as a rule in a dressing room in the ward, or in a small operating room reserved for such cases.

Chemotherapy

An effort was made last year in one of our hospitals to determine the value of chemotherapy in association with débridement and closed fixation. In a small number of cases (fifty) roughly half were treated by careful débridement and fixation; the other half, by débridement, chemotherapy, and fixation. There was no appreciable difference in the results or in the healing time. It is our conviction that in severe wounds the only sound prophylaxis is the careful removal of all devitalized soft tissue. No amount of chemotherapy, local or general, can be a substitute for surgical excision.

The attitude that the sulphonamides are the complete salvation and answer to all the hazards of war wounds, and that, once the magic powder has been dusted in, nothing more is necessary, is regrettable. Indeed, during the days of the severe air bombardment in England, evidence of such a conviction on the part of some of the casualty surgeons was noted. Patients with severe wounds were brought into the hospital after an interval of some days with gross infection, the notes showing that the wounds had been cleansed and sulphanilamide had been applied. Exploration of such wounds frequently showed deep pockets of infected blood clot beneath fascia and in some cases bits of battle dress or other clothing.

In no case are exploration, débridement, and decompression more urgent than in those wounds resulting from the casing of high-explosive aerial bombs. A small sharp fragment, traveling at high velocity, usually with a rotary motion, causes a relatively insignificant wound of entry, but may do extensive damage to muscles beneath. Trueta has pointed out

the necessity for thorough exploration in such cases, and our experience has confirmed his observations.

Closure of Wounds after Excision

There is a great desire on the part of surgeons when dealing with compound fractures, and indeed in extensive soft-tissue wounds, to complete the procedure by covering the area with skin,—in other words, to suture the wound. This desire has been stimulated by reports of cases treated successfully with the aid of a sulphonamide introduced before closing. It is not a policy to be encouraged when dealing with war wounds, particularly with compound fractures which are produced by missiles or external agents.

Reports from an area of active operations stress the fact that wounds sutured in the forward area have been badly septic on arrival at the base. The following communication from a consulting surgeon is an example: "A large number of wounds have been operated on in the forward area. The recognized débridement was carried out in as many early cases as possible. The wounds were saucerized, dusted with sulphanilamide, and packed lightly with vaselin gauze. All these cases did extremely well. Some wounds had been sutured, but, with the exception of a very few cases, were badly septic on arrival at the base, with sutures cutting out and the patient in pain from suppuration under tension. The question of tension in 'track' wounds was an important factor, especially when the track leads through a muscle mass as in the thigh. Operation entails enlargement of the skin wounds and incision of the deep fascia."

The Director of Medical Services for the Australian Forces in the Middle East circulated a memorandum which included the following recommendations: "That after excision, all wounds be left open and *no* attempt to suture be made, except in cases of gunshot wounds of the skull, thorax, abdomen, and large superficial joints. That after excision of wounds in muscular areas *no* buried catgut sutures be used; the only ligature material buried in the wound is that necessary to control hemorrhage."

A memorandum for circulation to the forward medical units with the Canadian Corps suggests that in the forward areas no wounds, except minor cuts, be closed. Prophylactic use of sulphanilamide, both locally and orally, is advised; the time and amount given is to be noted on the field medical card and rapid evacuation to a properly organized operating center is urged. The memorandum clearly states that the application or administration of a sulphonamide in no way lessens the urgency for rapid evacuation. Whatever the merits of closing wounds in civilian practice, one feels very strongly that there is little place for it in the treatment of war casualties. Necrosis of bone is the result of infection locked up in the closed wound, particularly if, when the infection has occurred, it is not drained adequately. In seventy-five cases of compound fracture, treated by excision, packing, and plaster fixation, we have seen no cases of necrosis due to infection. In the open wound, protective granulations quickly

cover the exposed bone at the base of the wound. In the closed wound, tension from serum and blood clot increases, and, if infection is present, it invades the fascial spaces, interfering with blood supply, and creates all the conditions which favor bone infection.

WOUNDS OF THE EXTREMITIES

In numbers at least, wounds of the extremities remain the greatest single problem in war surgery. Severe injuries to the soft tissues or bones and joints of the extremities form a very large part of the casualties. One surgeon has written that wounds of the extremities constitute 70 per cent. of the casualties. It is for this reason that field surgery is primarily the surgery of the extremities.

The handling of extremity wounds in battle depends upon the severity of the injury and the transportation facilities. Some of the wounded will be seen by their regimental medical officer. In these cases hemorrhage should be controlled, the wounds should be inspected and covered by sterile dressings, and splints should be applied to fractures. Morphine should be given as needed. Ordinary casualties are picked up at the regimental aid post by a detachment of the field ambulance and ultimately find themselves at a main dressing station. In mobile warfare many casualties are picked up by cruising vehicles of all sorts and brought back to the nearest aid post, be it regimental or otherwise. It has already been suggested that in mobile warfare experienced surgeons with adequate equipment should be available as far forward as what is known as the main dressing station of the field ambulance. Some of the casualties may be evacuated farther down the line after sulphanilamide has been applied to the wounds. This depends on the facilities for transportation. In certain circumstances air transportation may be available for seriously injured patients—notably those with wounds in the abdomen, head, and chest—after the necessary measures of resuscitation have been employed. The volume and extent of operating done in the forward area varies with the speed of the advance, the interference with communications, and the available shelter. Certainly, if limbs and life are to be saved, many penetrating wounds and compound fractures should be subjected to débride-ment and fixation. Whether this procedure be carried out here or in the comparative quiet of stations farther away from the line will depend on the violence of the fighting.

Essential Principles of Operative Treatment

Certain first principles of operative treatment should be recognized wherever the procedure is undertaken.

1. It is much simpler to operate expertly on the thigh and leg in cases of compound fracture if extension is applied as a first procedure; some sort of simple extension frame is necessary, which will allow the use of skeletal traction while the surgeon is operating and be adequate for the application of plaster with the minimum of assistance.

2. A thorough exposure of muscle and soft tissues is essential in wounds caused by bomb or shell fragments. The decompression of subfascial hematomata must be adequately carried out. Radical skin incision is unnecessary.

3. All devitalized muscle should be removed. The surgeon should bear in mind the blood supply of muscles like the sartorius and gracilis, and should remember that in wounds involving them it is frequently necessary to excise the whole muscle.

4. Foreign bodies, such as bomb fragments or bits of clothing, should be sought and removed. The search for devitalized muscle and the necessary drainage of hematomata will usually lead one to them. On the other hand, an extensive search for high-velocity missiles, such as machine-gun and rifle bullets, is not justified. Such wounds rarely necessitate radical operation.

5. The neurovascular bundle should be carefully avoided.

6. The incisions should always be in the long axis of the limb.

7. In the forward area, since most of the injured will need to be evacuated, wounds should never be closed, but should be packed with gauze and the whole region immobilized in plaster. In the case of the femur, it may be that time and supplies will not allow the application of a spica. Opinion in the desert campaigns has been rather divided. In one command, it is observed that spicas have not been sufficiently comfortable for long transportation, and it is the custom, therefore, to use a firm supporting bandage for the thigh, reinforced by some plaster. Fixation is obtained by a Thomas splint and skeletal traction. The light plaster includes the lateral bars of the splint. In another command, spicas are used satisfactorily, and reports from the base comment on the comfort of the patients during transportation. In all cases of plaster immobilization the patient should be detained for at least twenty-four hours before being evacuated, and, if there is doubt about the circulation, the plaster should be split before he leaves.

CONTROVERSIAL POINTS IN CLOSED-PLASTER METHOD

There are certain controversial points concerning the closed-plaster treatment which it may be helpful to consider.

Extension

Trueta, in his writings, says very little about the problem of extension in compound fractures of the femur. The author discussed this point with him in England. He pointed out that with severe soft-tissue injury a good deal of muscle is sacrificed and tone in the remaining muscle is reduced. The problem is then quite different from a simple fracture of the femur in a healthy adult. It is generally agreed that fixation without extension cannot adequately maintain length in such cases. The author has had occasion to confirm the truth of Trueta's observations, as shown by the following case:

A patient with a severe thigh wound and compound fracture of the femur was admitted. Débridement was carried out and extension was maintained during the operation by a Kirschner wire through the tibial tubercle. A good deal of muscle was lost. The wound was packed and a supporting bandage was applied. The patient was then placed on a Thomas splint with traction of fifteen pounds maintained by the Kirschner wire. Roentgenographic examination the following day showed about one inch of separation. The traction was then reduced to eight pounds, but the separation persisted. The traction was finally removed but the ends did not come together. The ends of the bone were then pushed together, and the patient put in a plaster spica. The fragments ultimately united in good alignment. Although the wound was large, it remained clean, and the first plaster was not changed for ten weeks.

On the other hand, as Trueta pointed out and we have confirmed by experience, the closed-plaster treatment can be combined with extension wherever indicated, as in many compound fractures of the femur. In compound fractures of the tibia of an oblique or spiral type it is our practice to leave the Kirschner wire in place following the operation and to apply the plaster so that extension may be used if necessary when the patient is returned to the ward. In many of those cases in which the patients are ultimately transferred to a base hospital treatment is by skeletal traction. The wounds, however, continue to be treated by the closed method.

Type of Packing

We have found it an advantage to have the bottom layer of gauze at least treated with vaselin or some lubricant. An excellent material is that known as "jellonet", prepared originally for the moist-dressing treatment of burns of the face. A lining for the wounds is made with a layer or two of jellonet, and the main cavity is packed evenly with gauze. The packing should not be too tight, but should be applied snugly to the bottom of the wound. On the surface it should be flush with the skin. We have found that when plain gauze is used, and if a considerable period elapses before the plaster is changed, there is a tendency for the granulation to grow into the meshes, and it is removed only with some difficulty.

Fixation

We have continued to use skin-fitting plasters and have found them satisfactory and comfortable. Rarely has it been necessary to cut them. In one of our hospitals the pattern type of plaster slabs are used to some degree. They cut down time in the hands of those experienced in their use.

We have had, as yet, little experience in the use of the Roger Anderson pin fixation in the treatment of compound fractures. It would seem to be a procedure not generally suited to severe compound injuries demanding extensive skin incisions. Certainly its use is impractical in forward units. We have employed it to a limited degree in simple fractures, but the author is not convinced that it affords sufficient advantages over the more conservative means of fixation to warrant its adoption in every base hospital as a routine procedure.

Change of Plaster

In those cases where relatively early treatment has been undertaken, the original plaster may be left for from four to six weeks or longer. We have not found that the odor has been troublesome. In those cases where active infection is already present at the time of operation, the first change of plaster will probably be necessary in from two to three weeks. The black filter-cloth bags made of material supplied through the Medical Research Council are of value in controlling disagreeable odors. We have had to use them very little on our wards.

Skin Grafting

In cases where there has been extensive loss of skin we have employed skin-grafting in the later stages. This is seldom necessary in compound fractures. As a rule, the wound heals before the fracture.

Local Chemotherapy

As already indicated, we could find no evidence that wounds packed with sulphanilamide did better than those without it. This is also the experience of at least one other group of surgeons who are attempting to gather accurate information on this point for the Medical Research Council. In a recent communication from a New Zealand unit in the East, the officer in charge of a division of surgery concludes that wounds do better without local chemotherapy; he considers that local treatment delays healing. On the other hand, in those cases where active infection is already established before reaching the hospital, local and general chemotherapy have been used as an adjunct to surgery.

We have seen no instances of gas gangrene in wounds which have been treated primarily in our own hospitals by débridement and closed plaster. On the other hand, we have had three cases of extensive gangrene following primary treatment elsewhere.

Secondary Hemorrhage

In only one instance has secondary hemorrhage been encountered in relation to the closed-plaster treatment. This was a case of compound fracture of both bones of the leg. The patient was admitted to one of our hospitals some days after preliminary treatment in another center. The wound was already infected. It was further opened and packed, and the limb was immobilized. Subsequently it was noted that adequate drainage had not been provided, and evidences of hemorrhage were noted by the sister as fresh staining through the plaster. With removal of the plaster in the operating room a tremendous hemorrhage from the anterior tibial artery occurred. We felt that the firm pressure of dressing and plaster had adequately controlled the bleeding in the emergency, and thus allowed time to call the surgeon and get him to the theater.

CRUSH SYNDROME

We have encountered three cases of crush syndrome. An account of

one of them has already appeared in the literature. The pathology of this now fairly well-recognized condition has been described by Bywater and others. It is important to try to differentiate it from shock, with which it may be confused in the early stages. We, unfortunately, have had insufficient experience with the treatment by intravenous alkalis to judge its efficiency, but the rationale seems sound, and the author knows of no other effective type of therapy. Now that we are aware of the pathology, we look for earlier diagnosis and more success in treatment.

FAT EMBOLISM

Fat embolism has been observed much more frequently than in civilian practice. It may be due to the fact that most of our young surgeons are alert to the possibility of its presence as a complication in fractures. Any patient who, following a fracture, shows such symptoms as mild delirium and diffuse chest signs with increased respiratory rate, and particularly if he has petechiae over the upper chest and shoulders, should be investigated for fat in the urine and sputum. We are surprised at the number of cases which have been found, and also by the fact that in young soldiers it is not a very serious complication. The figures in one hospital show seven cases of fat embolism occurring in eighty cases of complicated fractures. Only one case was fatal. In another hospital one case out of six was fatal.

VASOSPASM

We have seen two serious cases of vasospasm in the lower extremity. The first one followed a bullet wound in the thigh, which traversed soft tissue and did not injure the artery or vein, but subsequent investigation showed a small hemorrhage in the sciatic nerve. This case went on to complete death of the muscles below the knee; they showed, on exploration, the characteristic appearance described by Griffith of Manchester, and the artery was in complete spasm. In spite of periarterial sympathectomy and other measures, an amputation above the knee was done. The other patient had a simple fracture of the tibia and fibula in the middle third. Little manipulation was required. Within twenty-four hours there was evidence of an extensive Volkmann's lesion, and exploration of the muscles showed the typical colorless appearance described by Griffith. In this case also an amputation above the knee was done. These two cases alone would provide a subject for prolonged discussion. The author wishes merely to call attention to this very serious condition. It is an alarming complication, and neither the etiology nor the treatment is sufficiently understood as yet.

FURTHER RESEARCH ON WOUND TREATMENT

We have recognized that careful observation and the keeping of records in special groups of cases must be the answer to the many unanswered problems of wound treatment. It is a fact, however, that just when there

is a rush of such cases the previous plans for such research are apt to become completely disorganized by bombing, the sudden moving of personnel, and the manifold exigencies of war. In the field, and there above all, careful effort should be made to record data. However, difficulties are greater, and too often patients, personnel, and records may all be lost. We in the Canadian Army feel that research along clinical and other lines should be made the responsibility of a special department under the directorship of a research worker, trained on very broad lines. He and his staff should coordinate attempts to solve the problems of war wounds, shock, and such others as are suggested from time to time. He should be free to plan the work, both in the base hospitals and the forward units, with access to such laboratories as are available.

CONCLUSIONS

In conclusion, there are certain main principles, of the soundness of which the author is convinced at the present time.

1. In mobile warfare it becomes a matter of the greatest importance either to evacuate the wounded by air or, failing this, to bring the facilities for early surgery to the patient.

2. The advantages of the closed-plaster treatment are paramount. It allows for safe transportation over long distances without the necessity for dressing during the journey. As already noted in reports from the East, "those who have been subjected to débridement and plaster fixation traveled well and looked fit on arrival". Furthermore, continued closed-plaster treatment at the base hospital would seem to be the method of choice. Our experience in Canadian hospitals after eighteen months encourages us to adopt the method as routine treatment.

3. It is clear from our experience in England, also from reports in Libya, that war wounds should not be sutured.

4. The use of sulphanilamide as a prophylactic measure is not on sufficiently firm ground to warrant the impression which is held by some surgeons that it will constantly prevent gas gangrene and other infection if applied to a contaminated wound. The author knows of no prophylactic against gas-forming organisms other than the early removal of devitalized muscle. When such débridement has been carried out and local chemotherapy used, we have been unable to see evidence of increased healing or lessening of infection when compared with those cases in which similar surgical treatment without chemotherapy has been instituted. On the other hand, sulphonamides given by mouth as soon as possible after injury may cut down the incidence of severe streptococcus infection, particularly when such cases are delayed in reaching an organized operating center. The application of sulphonamides to superficial wounds, particularly burns, is of undoubted value, but such routine use on the deeper penetrating wounds does not lessen the urgency for surgical treatment.

PRIMARY GENETIC DYSPLASIA OF THE HIP WITH AND WITHOUT CLASSICAL DISLOCATION *

BY VERNON L. HART, M.D., MINNEAPOLIS, MINNESOTA

From the University of Minnesota Medical School, Minneapolis

Classical congenital dislocation of the hip is secondary to a primary genetic dysplasia of the hip, or flat acetabulum, and develops during intra-uterine life, or in the course of the first or second year of postnatal life. Dislocation is a consequence of the primary dysplasia or "flat socket"; it is a secondary and incidental phenomenon. "Dysplastic acetabulum" is a term now generally accepted, and means a congenital and genetic anomaly of the acetabulum, with hip-joint instability and incongruity. The primary anomaly is not limited to the acetabulum, but involves all mesodermal structures of the hip joint. Aplasia or hypoplasia of the roof or buttress or posterosuperior portion of the rim of the acetabulum causes a flat socket which is the important expression of the dysplasia of the pelvis and hip joint. Dislocation of the femoral head may result because the hypoplastic and insufficient roof of the acetabulum lies in the axis of transference of forces of body weight and muscle contraction. Acclivity of the roof of the socket is the principal anatomical feature and a constant defect in congenital dislocation of the hip (Fig. 1).

Actual dislocation can, but need not necessarily, occur. Primary dysplasia of the hip without dislocation, but with varying degrees of subluxation, is a distinct clinical and roentgenographic entity, and is the one to receive consideration in this paper. The two entities, with and without dislocation, are identical in their etiology, but are different in their clinical and roentgenographic manifestations. Either entity may exist as a unilateral or bilateral lesion of the hip joint; frequently the two entities are present in a single patient with bilateral hip-joint dysplasia (Fig. 2).

Hip dysplasia with potential dislocation in a child one or several months of age may, if not properly treated, become a complete dislocation before or soon after the child starts to walk. Dysplasia of the hip with dislocation was at some previous period a potential dislocation; but hip dysplasia without dislocation does not necessarily progress to a complete or classical dislocation. Whether or not a gradual transition occurs from potential to complete dislocation depends on the degree of hypoplasia of the acetabular rim, the sex, the position *in utero*, and the forces of muscle contraction and weight-bearing. It is now an established fact

* This paper is based upon material presented in scientific exhibits at the Ninth and Tenth Annual Meetings of The American Academy of Orthopaedic Surgeons, held in New Orleans, Louisiana, January 1941, and Atlantic City, New Jersey, January 1942.

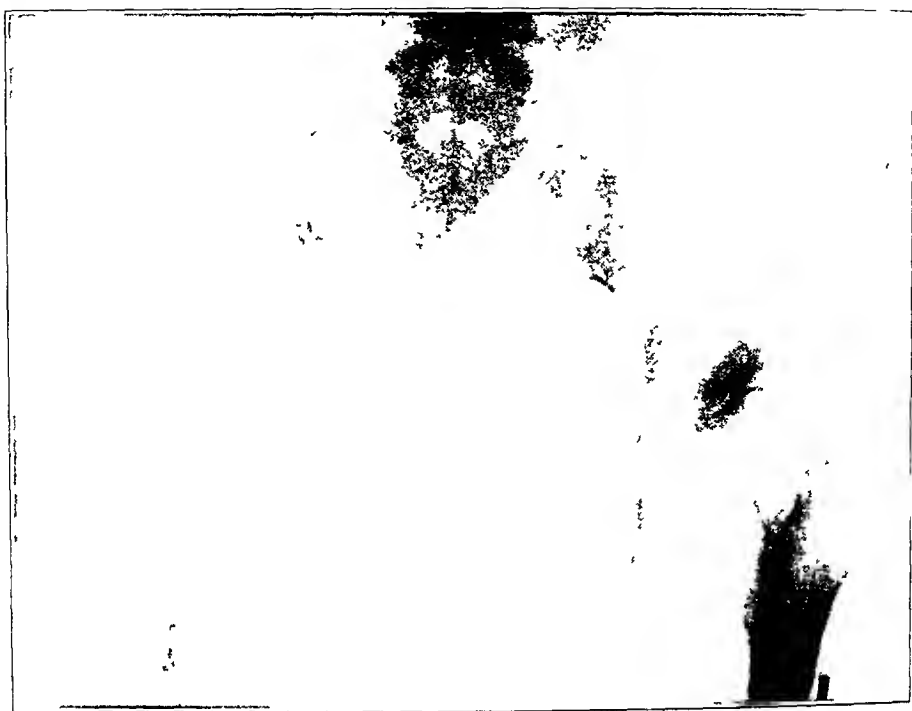


FIG. 1

Roentgenogram of patient twenty years after manipulative reduction of congenital dislocation of the left hip. Note that the principal anatomical feature and constant defect in congenital hip is acclivity of the roof of the acetabulum. The patient is now twenty-five years old. There is no evidence of traumatic arthritis which is inevitable at a later age. Secondary roentgenographic features of maldevelopment of the femoral head and neck are apparent, also the adaptive physiological sclerosis of the roof of the inadequate acetabulum.

that dysplasia of the hip with subluxation, which was thought to be only a precursor of the classical dislocation, may remain as a permanent deformity with characteristic clinical symptoms and roentgenographic findings.

In the textbooks, the chapter on congenital dislocation of the hip is incomplete, since only the entity "dysplasia with dislocation" is considered. The entity "dysplasia without dislocation", which is more common, and frequently more disabling than the classical dislocation, should be included. The terms "dysplastic acetabulum" or "hip dysplasia without dislocation", "preluxation", "potential dislocation", "inadequate acetabulum", "incompetent acetabulum", "flat socket", and "subluxation" are synonymous, since they are expressions for a single entity. The textbooks should include a chapter entitled "Dysplasia of the Hip". Two entities should be considered in this chapter: (1) "dysplasia with dislocation", and (2) "dysplasia without dislocation". Putti stated that subluxation is rather more common than dislocation, and that, while the latter can be easily diagnosed and therefore may be treated, the subluxation does not usually become evident until late in life, when every chance of cure is gone.



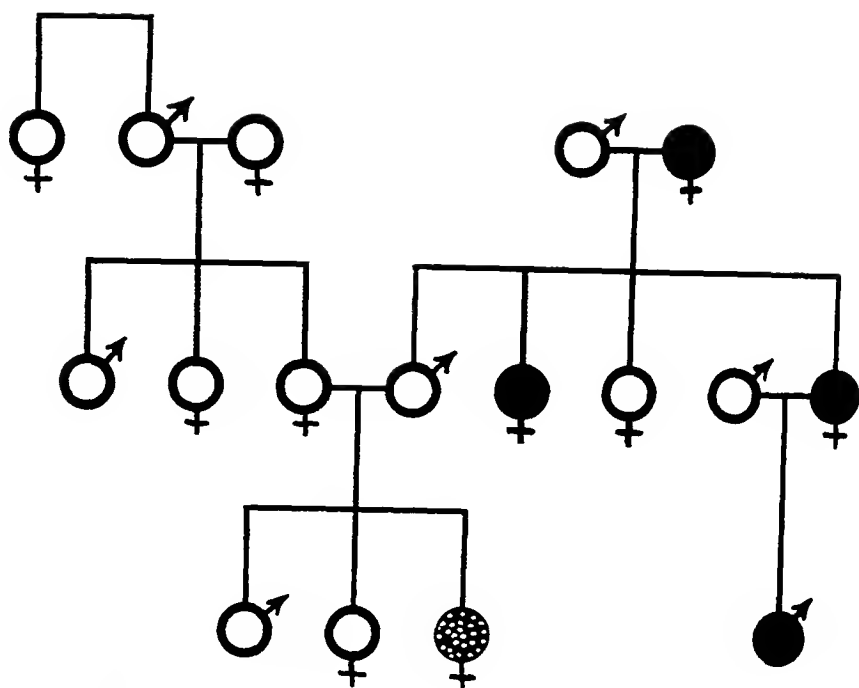
FIG. 2

Patient has always been disabled with a unilateral hip dislocation. She is now forty-six years old, and has experienced pain and stiffness during the past year in the opposite "normal" hip. Note the characteristic signs of primary hip dysplasia of the "normal" hip with early traumatic osteo-arthritis. Careful study of dysplastic acetabula shows that bilateral cases outweigh the unilateral, which is the opposite of statements made by earlier authors.

HEREDITARY CONDITIONS

Many authors have reported genetic occurrence in families in about 20 per cent. of all cases of congenital hip dislocation. It has been recognized since the first report by Ambroise Paré that the hereditary factor is of real importance. A notable and fundamental contribution to our knowledge of congenital dislocation of the hip was reported by Faber in 1937. Previous to Faber's work, all genetic investigations were based on the concept of a "dislocation gene" or diseased chromosome. The only "patients" in the genealogical studies were those with classical dislocation. Faber's research was based on the concept that the heredity, upon which dislocation of the hip depends, is not itself the hip dislocation, but, instead, is a primarily existent defect or acetabular anomaly which is in general designated as a flat socket. Because of a flat socket, an actual dislocation of the joint can, but need not necessarily, occur. There is no "dislocation-gene-conditioned chromosome", but there is a "hip-dysplasia gene". The hereditary factor is not the dislocation, but is a primary hip and acetabular dysplasia. Congenital hip dysplasia with and without dislocation are clinical expressions of the same gene-conditioned chromosome. They have the same heredity.

Roentgenographic consanguinity investigations were made by Faber



- Normal
 ● Dysplasia with dislocation
 ● Dysplasia without dislocation

FIG. 3

One of Faber's roentgenographic consanguinity studies shows that in the family of the mother of the patient no carriers were found, while in the family of the father four carriers of the primary hip dysplasia without dislocation were found. (Reproduced from *Stammtafel 8. Zeitschrift für Orthopädie, LXVI, 160, 1937.*²)

on all living members of the families of ten children with congenital dislocation of the hip (Fig. 3). The ten children were considered ostensibly sound in their heredity by those who accepted the concept of a "dislocation gene". From these studies, Faber demonstrated that dysplasia of the hip joint without dislocation was three times as frequent as was classical hip dislocation. In a total of ninety-eight cases of primary hip dysplasia, twenty-five were with dislocation and seventy-three without dislocation. The occurrence of primary acetabular dysplasia is, therefore, four times as frequent as had been supposed up to the present time, from the sole consideration of hip dislocation. In some of the families, only a few individuals manifested classical dislocation, while many showed hip dysplasia without dislocation. In one family, no dislocation was observed although many flat sockets were demonstrated. Not all apparently normal individuals were genetically sound. Some patients with

hip dislocation had parents who were normal in (phenotype) appearance, but roentgenographic studies showed one of the parents to have a flat socket. The affected parent, although clinically normal, was a latent carrier of the gene.

Variations in the manifestation or expressivity of the gene indicate that other conditions are active in determining the penetrance of the gene, and thus the expression of the character. Under the influence of function, a growing child with hip dysplasia without dislocation may in adolescent or adult life present a spontaneously healed or normal hip joint; the apparently normal individual would be genetically abnormal and a conductor or latent carrier of the "hip-dysplasia" gene. In many instances, it is not possible to measure the exact environmental condition which can affect the gene action. Genes primarily active in the development of a trait may act differently under various genotypes (genic milieu). A trait develops as the result of the interaction of several gene pairs; and, if one of these pairs is different, the primary gene may not be able to produce a trait as completely or as incompletely as it could under the other genic complex. Some genes are secondary in their nature of action, in that they modify the action of the gene pair primarily associated with the trait. A true genetic history cannot be gained from a study limited to classical dislocation, since this expression of the gene occurs only if the environment, genic and otherwise, is proper for that complete expression. Only by roentgenographic consanguinity studies can a true genetic picture with all the variations of the penetrance and expressivity of the gene-conditioned chromosome be gained.

The sex ratio of the total number of dysplasias approached the universal average, showing that there is, after all, not such a very great difference in the dysplasias of the hip joint between the sexes. The sex ratio of the total number of dysplasias with dislocation, however, revealed a preponderance of dislocations among the female sex. The ratio between the sexes did not vary from previously reported investigations on great numbers of cases, which revealed a ratio of female to male, of six to one. In the female, the dysplastic hip can lead much more easily to complete dislocation than in the male. This constant sex distribution is understood if it is true that a sex-conditioned structure of the pelvis exists,—the female having a more perpendicular innominate bone and a shallower acetabulum. The phenomenon of female-sex predominance with actual dislocation requires further investigation.

Sex linkage in the hereditary pattern does not exist, because the genealogical trees show transmission of the genetic character of hip dysplasia from father to son. The dysplasia gene is transmitted usually only from one of the parents, and a recessivity of the genes predisposing to primary dysplasia of the hip is not probable. Hip dysplasia is due to a dominant gene.

Mendelian ratios cannot be predicted in human families because the genotypes are not known at the time of mating, and the offspring

do not occur in numbers great enough to fulfill the mathematical expectancy.

PRIMARY ROENTGENOGRAPHIC FEATURES

There is no one particular roentgenographic form of hip joint to be exclusively designated as the normal. There is a range of normals, since there are numerous variations which certainly do not fall outside the classification of the normal. A range of normalcy so generous and wide will be recognized in order to eliminate error which

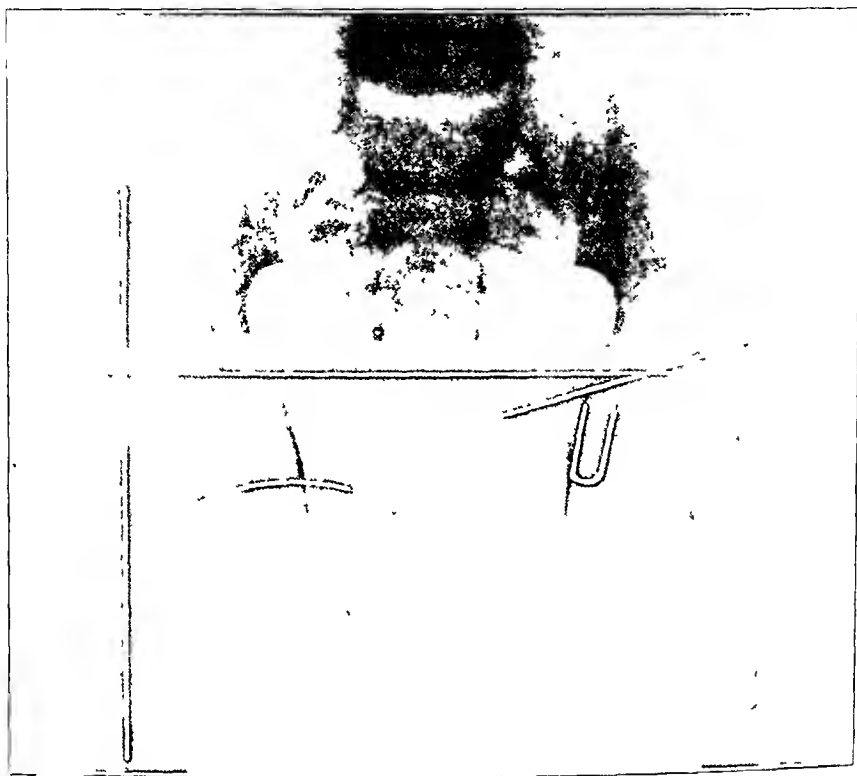


FIG. 4

Roentgenographic study of a normal hip (aged two years). A horizontal line is drawn on the roentgenogram through the clear areas in the depth of the acetabula, which represent the triradiate or Y cartilages. This line is called the Y line. A second vertical line is drawn through the lateral border of the acetabulum and the Y line. Normally the capital epiphysis lies below the horizontal line and within the lower medial quadrant formed by the Y and vertical lines. The angle of incidence of the roof of a normal acetabulum is about 20 degrees. This angle is formed by the junction of the Y line with a line passing from the depth of the socket at the Y line through the lateral border of the acetabular roof.

In case of unilateral hip-joint dysplasia, the vertical line is drawn on the normal side; and on the opposite side a parallel line is drawn at an equal distance from the mid-line.

In hip dysplasia without dislocation, but with varying degrees of subluxation, the capital epiphysis lies below or partially above the horizontal or Y line, but lateral to the vertical line. In hip dysplasia with actual dislocation, it lies above the Y line and lateral to the vertical line.

Note Shenton's line and the tear-drop. Also note the line which measures the distance from the most proximal shadow of the diaphysis to the Y line.

would necessarily result from a narrow and rigid definition of the normal.

The following description of the anatomical and roentgenographic appearance of the normal hip is quoted from Wiberg:

"The acetabulum of the hip joint is a hollow which embraces 170 to 175 degrees of a sphere, and whose opening looks forwards, outwards and downwards. Lining the circumference of the hollow and enclosing the acetabular fossa is the lunate surface, a horseshoe-shaped surface with an anterior and posterior horn which articulates with the head of the femur. Articular cartilage is only found on the lunate surface. The acetabular fossa is filled by the ligamentum teres and fat tissue, and continues in front and below into the obturator foramen by means of the acetabular notch (incisura acetabuli). Attached to the bony margin of the acetabulum and increasing the depth of its cavity is the cotyloid ligament, otherwise known as the labrum glenoidale or limbus of the hip joint. Its inner surface, which is concave, constitutes a direct continuation of the articular cartilage in the acetabulum; its outer surface is convex. The capsule is attached superiorly to the bony margin of the acetabulum outside the attachment of the cotyloid ligament, and consequently there is a space between the two. At the acetabular notch, the cotyloid ligament continues into the transverse ligament.

"The femoral head forms about two-thirds of a sphere and is practically spherical in shape. Two-thirds to three-quarters of the head are received into the acetabulum and cotyloid ligament.

"The roentgen picture of an adult hip has a number of characteristic features [Fig. 6]. As a rule, the acetabulum appears as a practically circular segment. The upper part, the roof, runs practically horizontally, with the vertex of the concavity lying almost directly above the center of the head. The inferior part of the acetabulum, the floor, lies practically vertically, and corresponds anatomically with the acetabular fossa. The transition between these two parts of the joint cavity is marked by a step. At the same time the bottom of the acetabular fossa, the acetabular floor, gives rise to the outer side of the formation which is called the U figure, or the tear figure, whose inner side is formed by the bony border of the small pelvis. That this is the way the U figure is formed has been proved by Werndorff, who made it disappear in the roentgen picture by sawing out the bottom plate of the acetabular floor.

"The bone in the acetabular roof nearest

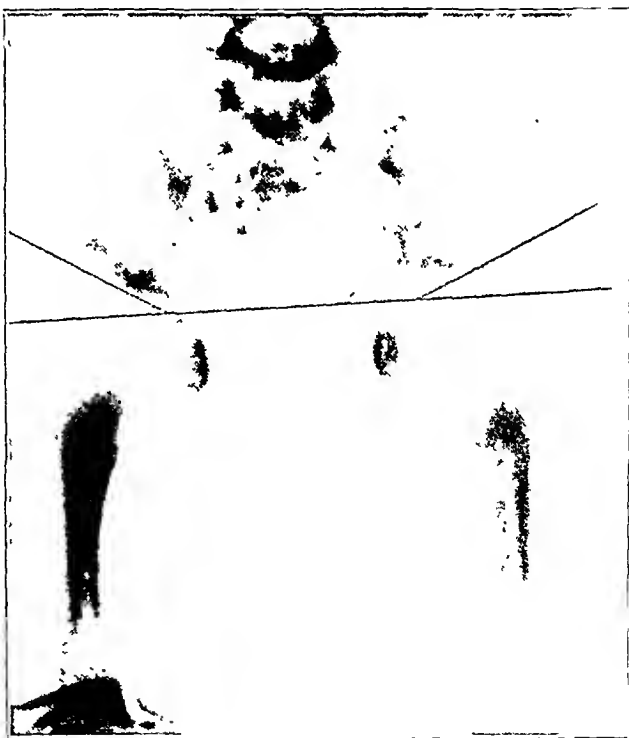


FIG. 5

Roentgenogram of a normal newborn (aged one day). Note the acetabular index.

the articular cartilage is comprised of a thin layer of cortex which appears as a dense zone in the roentgen picture . . . [Fig. 6].

"If the line of the inner curve of the neck is extended, it will continue along the upper border of the obturator foramen—Shenton's line [Fig. 4].

"Children show a number of characteristic details in the roentgen picture, due to the incomplete ossification of their joints [Fig. 4]. The cartilage connecting the three pelvic bones in the acetabulum appears as a gap, and because this cartilage has the shape of a Y anatomically, it is called the Y [or triradiate] cartilage . . . therefore . . . the line which is drawn through both the gaps [is known as] the Y line. If the cartilaginous area is broad, it may be difficult to know where to draw the Y line. . . . The bony part belonging to the ischium [is selected] as a definite point, and the line [is drawn] so that it touches it. As long as the epiphyseal nucleus is still separated from the rest of the neck by an epiphyseal line, the most medial part of the diaphysis of the neck looks like a spine, and is called the spine of the neck."

Proper roentgenographic technique is essential to prevent distorted views and erroneous measurements. The patient must be relaxed and placed flat on his or her back. The lower extremities should be in contact, the hips extended, and the patellae facing directly forward. The roentgen tube must be centered in the mid-line of the body and directly over the superior border of the symphysis pubis.

Roentgenographic diagnosis of hip dysplasia without dislocation is

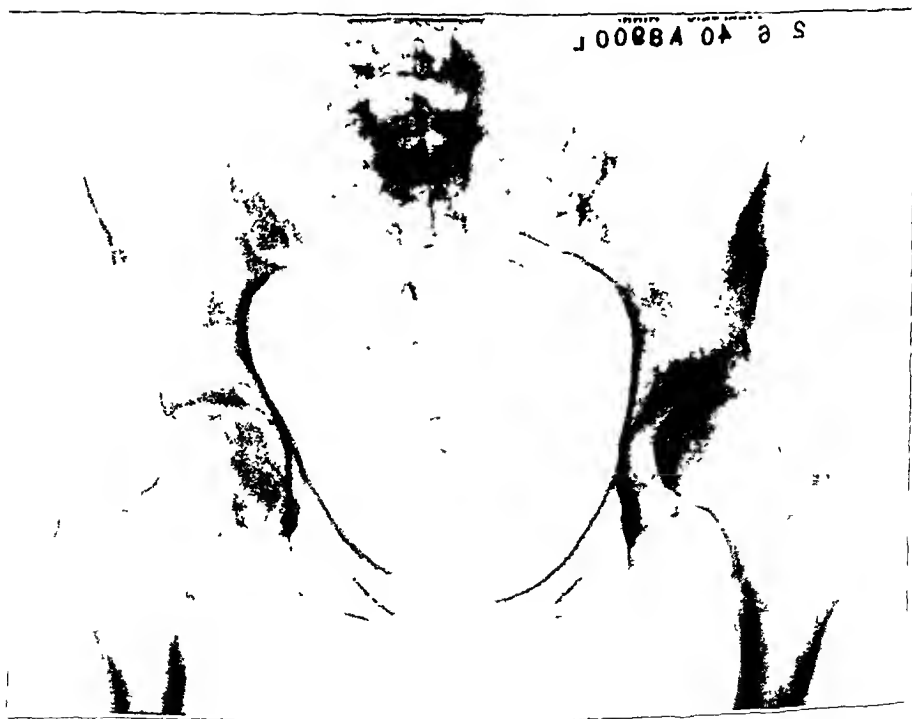


FIG. 6

Note the characteristic features of primary dysplastic acetabulum (Calot's half-citron socket). There is physiological adaptive sclerosis of the acetabular roof. The patient's complaints were hip fatigue and a mild limp when tired. Symptoms were completely relieved by rest and change of occupation. The opposite hip is normal. The patient is a female in the period of early adult life. Her sister is disabled with a classical hip dislocation.

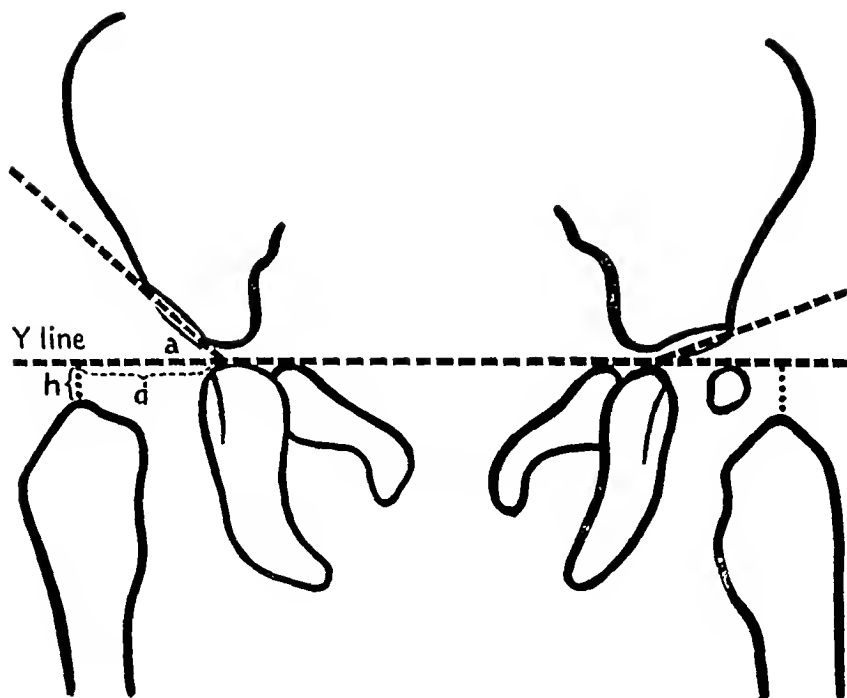


FIG. 7

Hilgenreiner's measurement. Note the Y line, acetabular index (a), high position of the diaphysis as measured from the most proximal shadow of the diaphysis to the Y or triradiate line (h), increased distance from the most proximal shadow of the diaphysis to the acetabular floor (d). (*Reproduced with slight changes from Abbildung 1. Zeitschrift für Orthopädie, LXVI, 151, 1937.*)

very difficult during the first months of life, and the condition is rarely recognized except where the routine examinations of the newborn are made. Most often it is dislocation of the opposite hip which leads to its discovery. Putti recognized and treated by his abduction method a dysplastic hip without dislocation in a child only thirty-four days old. Unless dislocation is present on the opposite side, it is advisable to wait until the third or fourth month before reaching a definite conclusion; then the ossification center of the femoral head is visible in the roentgenogram and the possibility of error is reduced.

Hip dysplasia or "flat socket" refers not only to the steep acetabulum, but also to all joint-forming parts of the hip joint. However, the primary anatomical and roentgenographic feature of hip dysplasia is the abnormal acclivity of the roof of the acetabulum, which increases the angle of incidence of the roof of the socket. The acetabular index is the angle formed between the roof or iliac portion of the acetabulum and a horizontal line passing through the Y or triradiate cartilages (Fig. 4). Normally the acetabular index in a child is about 20 degrees. The angle is increased to 30 or more degrees in dysplasias (Fig. 7). Kleinberg and Lieberman studied the angle of incidence of the roof of the acetabulum and found the average angle of incidence in the normal newborn to be

the articular cartilage is comprised of a thin layer of cortex which appears as a dense zone in the roentgen picture . . . [Fig. 6].

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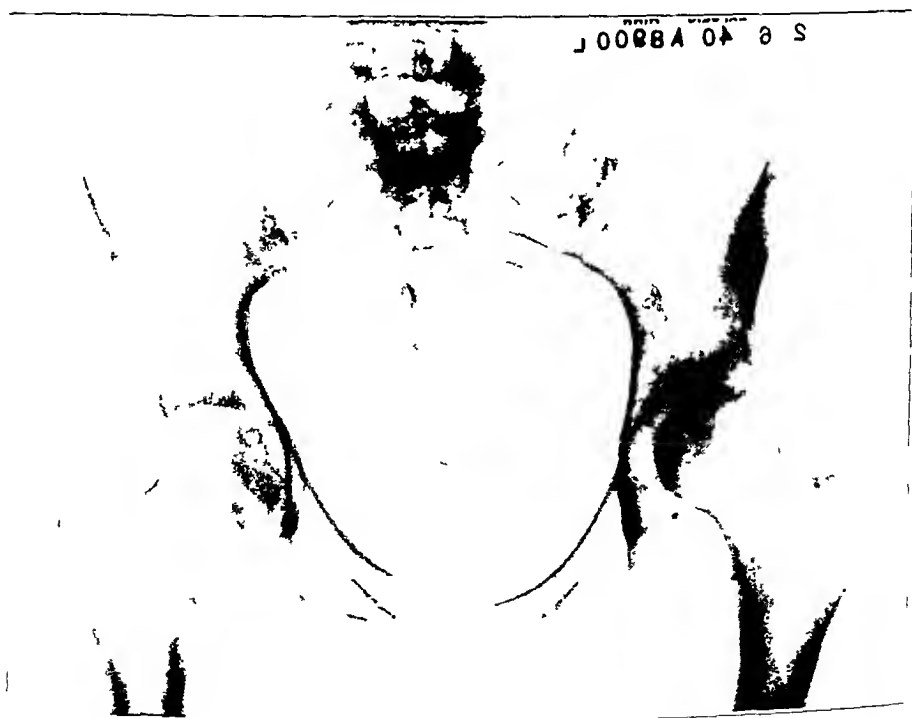


FIG. 6

Note the characteristic features of primary dysplastic acetabulum (Calot's half-citron socket). There is physiological adaptive sclerosis of the acetabular roof. The patient's complaints were hip fatigue and a mild limp when tired. Symptoms were completely relieved by rest and change of occupation. The opposite hip is normal. The patient is a female in the period of early adult life. Her sister is disabled with a classical hip dislocation.

4. Disturbance of Shenton's (obturator-coxofemoral) line.
5. Delayed bony bridging of the ischiopubic synchondrosis.
6. Increased distance of the most superior shadow of the metaphysis or neck of the femur from the acetabular floor or tear-drop shadow (if it is present).
7. High position of the diaphysis as measured from the most proximal shadow of the diaphysis to the Y or triradiate line.
8. The increase in the distance from the shadow of the most medial part of the metaphysis of the neck, which looks like a spine and is called the spine of the neck, to the acetabular floor, or tear-drop, and the decrease in the distance to the Y line.
9. Frequently a classical dislocation of the opposite hip.
10. The position of the limbus cartilage and the relation of the cartilaginous acetabulum to the femoral head as shown by arthrography.

Putti, one of the greatest authorities on hip dysplasia without dislocation, or preluxation as he called it, depended on the following triad for diagnosis (Fig. 7):



FIG. 9

Note the characteristic features of primary hip dysplasia with acclivity of the acetabular roof and subluxation. Secondary changes of traumatic arthritis with loss of joint space, sclerosis, cystic rarefaction, and double acetabular floor have been added to the primary features. The patient's onset of symptoms had occurred six years previously, with hip fatigue and limp. One year previously severe pain, loss of motion, and deformity developed. She was totally disabled for work, and was not relieved by conservative measures. The opposite hip presents a very mild expression of dysplastic acetabulum. She has a sister disabled with bilateral hip dysplasia, with dislocations reduced in 1903 by Dr. Adolf Lorenz. (See Figure 10.) Arthrodesis of the hip was advised and performed.

1. An increased distance between the upper femoral diaphysis and the acetabular floor.
2. Hypoplasia or delayed development of the epiphyseal nucleus of the femoral head.
3. An abnormally steep or short acetabular roof.

Functional instability and anatomical incongruity are the important expressions of congenital dysplasia of the hip, and can be identified by:

1. Hilgenreiner's measurements (child). (See Figure 7.)
2. Calot's half-citron-shaped acetabulum (Fig. 6).
3. Wiberg's pattern (adult).

SECONDARY ROENTGENOGRAPHIC FEATURES

Because of the repeated trauma resulting from abnormal sheering forces, mechanical instability, and incongruity of the dysplastic hip, secondary changes are added to the primary anatomical and roentgenographic features. These changes may be listed as follows:

1. Increased subluxation when compared with previous studies.
2. Delayed development of the epiphyses.
3. Delayed fusion of the epiphyses.
4. Maldevelopment of the femoral head and neck (Wolff's law).
5. Increased sclerosis of the acetabular roof. The degree of sclerosis is in direct proportion to the degree of maldevelopment of the acetabular roof,—physiological adaptive sclerosis (Fig. 6).
6. Coxa valga luxans (Klapp).
7. Osteochondrosis, coxa plana, Legg-Perthes disease, or osteochondritis deformans coxae juvenilis.
8. Traumatic hypertrophic arthritis of the hip joint or malum coxae senilis with: (a) narrowing of the joint space; (b) osteophytic deposits, capital drop, and double acetabular floor; (c) sclerosis of bone and areas of cystic rarefaction involving the weight-bearing areas of the acetabulum and femoral head (Fig. 8).

The author is aware of the fact that coxa plana or Legg-Perthes disease does not necessarily have a dysplastic acetabular background. He has observed several cases of coxa plana develop in clinically and roentgenographically normal hips. The acetabular changes were adaptive and developed secondarily to the deformed head. However, the author believes that primary dysplasia of the acetabulum may be the precursor of a group of cases with clinical findings and roentgenographic features that are indistinguishable from cases of coxa plana of unknown etiology. This problem should stimulate investigation.

Preiser in 1907 presented his theory that development of osteoarthritis in the hip was due to poor adaptation between the head and the joint cavity. Wiberg in 1939 conclusively demonstrated the correctness of Preiser's theory. He presented roentgenographic studies of nineteen cases with primary hip dysplasia before and after the development of secondary changes of osteo-arthritis.

The author believes that osteo-arthritis of the hip, or *malum coxae senilis*, is frequently traumatic arthritis and develops because of anatomical incongruity and instability of a primary dysplastic acetabulum. He has studied sixteen patients who had disability from dysplastic acetabula. Each patient had one member of the family disabled with classical congenital dislocation of the hip. The author's first case (Fig. 9) was recognized in 1935. The patient's sister had congenital dislocation of both hips (Fig. 10), which were reduced by Dr. Adolf Lorenz in Chicago in 1903. This patient with hip dysplasia without dislocation, but with secondary traumatic arthritis, was being treated for tuberculosis of the affected hip.

ROENTGENOGRAPHIC DIFFERENTIAL DIAGNOSIS

The following list of hip-joint lesions may at times require careful study for differentiation from primary hip dysplasias:

1. Coxa plana or Legg-Perthes disease,
2. Epiphyseal separation,
3. Tuberculosis,
4. Infectious arthritis,
5. Hypertrophic arthritis,
6. Aseptic necrosis,



FIG. 10

The patient had bilateral hip dysplasia with dislocations which were reduced by Dr. Adolf Lorenz in 1903 when the patient was three years of age. Note the signs of bilateral hip dysplasia with added changes of traumatic arthritis. The patient is now seriously disabled at the age of forty-two years. Her sister has hip dysplasia without dislocation, but with secondary changes of traumatic arthritis. (See Figure 9.)

7. Late septic hip,
8. Neoplasm,
9. Neurotrophic lesions,
10. Old fracture-dislocations,
11. Endocrine dysfunction.

CLINICAL FINDINGS

Clinical manifestations of dysplasia of the hip without dislocation depend upon the degree of incongruity, subluxation, acetabular instability, age, occupation, weight, activity, and general health of the individual; and also upon whether or not the opposite hip is dysplastic, with or without dislocation.

If classical dislocation does not occur soon after birth, then there are essentially two possibilities:

1. The acetabulum returns to normal under the influence of function, with or without abduction treatment. The individual with a spontaneously healed dysplastic acetabulum will present no abnormal clinical findings or roentgenographic features in later life. The dysplastic hip with classical dislocation may return to normal after treatment, but the percentage which actually does return to normal roentgenographically must be very small.

2. The dysplastic hip without dislocation remains flat with incongruity and instability. Some of the patients in this group with mild maldevelopment of the acetabulum may at no time during life present any subjective or objective clinical findings. The hip dysplasia may never be recognized because it is asymptomatic. Roentgenographic study would be the only means of its recognition. Other patients in this group with slight subluxation are free from subjective or objective clinical findings during infancy, childhood, and adolescent life. During the period of early adult life the patient may complain, not of pain, but of a feeling of hip fatigue and a slight limp, especially when physically tired from work, unusual exercise, or sport (Fig. 6). Symptoms subside with rest, but recur weeks or months later. Clinical examination may be normal except for slight atrophy of the affected extremity. Roentgenographic study at this period demonstrates the features of the primary dysplastic hip, without secondary changes except for adaptive physiological sclerosis of the subchondral weight-bearing portion of the acetabular roof (Fig. 6). Symptoms of pain, fatigue, and limp increase with the years. Disability increases, and the periods of pain and limp are more difficult to relieve with rest. Osteo-arthritis gradually develops as a result of local frequently repeated microtrauma. Traumatic arthritis adds to the subjective and objective clinical findings. Stiffness, morning pain, limited motions, and deformity develop. The extremity often presents an adduction, flexion, and external rotation deformity, with apparent and real shortening. In middle or late adult life, the patient may be totally disabled for work (Fig. 9). Frequently the patient

has been treated for foci of infection, tuberculosis, sciatica, osteochondritis, and infectious arthritis; and has been deprived neither of the many "shots" and minor operations for removal of foci of infection, nor relieved of the mental and economic strain which are inevitable when searching for etiological factors over a period of years. It is very important to recognize the mechanical factors of painful dysplastic hips.

Symptoms may appear during childhood, and it may be extremely difficult to differentiate the lesion from Legg-Perthes disease unless a genetic study is made. Symptoms may not begin until adolescent life.

The lesion may be found accidentally if the opposite hip is being studied roentgenographically for dislocation. There is no doubt that bilateral hip dysplasia will be recognized more and more, due to the fact that more thorough examination of the "healthy" side will prove that it too is not normal. Not infrequently a patient, who has been disabled over a period of many years because of unilateral dislocation, will experience pain and stiffness of the "normal" hip. Roentgenographic study will reveal that the "normal" hip is actually a dysplastic hip without dislocation, but with secondary changes of traumatic osteoarthritis (Fig. 2).

It is true that the clinical onset and the severity of the disability are inconstant, but there seems to be some correspondence between the degree of dysplasia and the onset of symptoms. There is also some



FIG. 11

Roentgenogram of patient thirty-five years old. Note the primary and secondary roentgenographic features of bilateral hip-joint dysplasia without dislocation. The patient's brother has classical dislocation of both hips.

relationship between the extent of osteo-arthritis and the severity of clinical disability. This is not constant, however, since there are the factors of obesity, type of occupation, activity in sports, and general health which influence the onset of symptoms and the severity of the disability.

MICROSCOPIC PATHOLOGY

Microscopic pathological changes observed in the dysplastic hip with secondary traumatic osteo-arthritis were described by Sawyer and Ghormley in 1941. The author's material for study has been limited, but his findings correspond to the changes noted by Sawyer and Ghormley, who reported:

"1. The initial degenerative changes appear in the cartilage and are characterized by fibrillation, pitting, degeneration of the cartilage cells, and increased calcification of the deeper matrix.

"2. The marginal cartilage proliferates and shows few of the signs characteristic of degeneration.

"3. As the cartilage disintegrates and is worn away, the bone is exposed and becomes eburnated with thickening of the subchondral plate and the subjacent trabeculae by means of intramembranous ossification.

"4. The subchondral plate may or may not be thickened. The trabeculae are almost never increased in size in those areas that are still protected by cartilage, and most formation of new bone in these areas is of the endochondral type.

"5. The normal marrow is replaced by fat or loose fibrous tissue which, in some instances, dedifferentiates into osteoid tissue.

"6. The synovial membrane is invaded by fibrous tissue with markedly increased vascularity.

"7. Little evidence was found to support the hypothesis that arteriosclerosis is an etiologic factor of osteo-arthritis.

"8. Finally, no collections of lymphocytes were found which are characteristic of the infectious types of arthritis."

TREATMENT

Dysplasia of the hip without dislocation, in the author's experience, presents no characteristic clinical signs in the infant. The anomalous hip is recognized during infancy through roentgenographic studies because of dislocation of the opposite hip or in a routine roentgenographic examination of hips as practised by Putti. If the condition is recognized in an infant, with complete dislocation of the opposite hip, then the hip without dislocation should be splinted in abduction during the period of immobilization of the reduced dislocated hip. A mildly dysplastic hip in an infant, recognized by routine roentgenographic studies of the hips, however, should not be treated until after the fourth or fifth months, when a more certain conclusion can be made. Since an error can be excluded by waiting and spontaneous healing is possible during this period, there is good reason for the postponement of treatment.

If a dysplastic hip is present after the fourth month in an infant or child, then treatment in an abduction splint for several months or more, as recommended by Putti, is expedient.

As previously stated, many of the dysplastic hips without dislocation

remain asymptomatic for many years. The patients with symptoms of fatigue, pain, and limp should be advised to spare the hip, and refrain from strenuous sports, jumping, and long hikes. A rest period during the middle of the day is beneficial. Obesity must be prevented. The patient's occupation should not require long periods of standing or walking. Lifting and carrying heavy objects should be discouraged. A moderate raise to the heel of the shoe of the opposite, normal extremity may help to relieve symptoms, since elevation of the pelvis on the normal side will improve stability of the dysplastic hip in the standing position. A crutch or cane is often necessary, and should be used on the normal side to aid the gluteal mechanism and enhance stability of the dysplastic hip. Physiotherapy, various forms of hip spicas, roentgenotherapy, manipulation, and traction are measures which may give temporary relief. Conservative measures should always be tried first. If they fail, then operation may be considered.

At this point, the causes of pain and disability should be restated, since the recognition of them is a prerequisite to any well-planned surgical procedure. The disability is caused by hip-joint instability and incongruity during the early years, and by the additional factor of traumatic arthritis during the later years (Fig. 11). A perfect shelf operation does correct instability and, therefore, improves the patient's condition, but it does not correct the serious factor of incongruity. Therefore, operation may fail if the patient does not continue to guard the hip against overstrain as suggested under the conservative program. Osteo-arthritis may develop subsequently as a result of the remaining hip-joint incongruity.

Arthrodesis of the hip, intra-articular and extra-articular, must be considered in single or unilateral hip lesions after the additional factor of traumatic arthritis has increased the pain and disability. Watson-Jones' nail-fixation, arthroplasty, and McMurray's osteotomy should also be included in the possible surgical methods to relieve pain and disability of the dysplastic acetabulum with traumatic hypertrophic arthritis.

SUMMARY

1. One human trait which has been difficult to explain genetically is congenital dislocation of the hip.

2. An individual does not inherit congenital dislocation of the hip, but does inherit a primary defect, or hip dysplasia, which produces anatomical and physiological alterations of the joint called "flat socket". Only secondarily does actual dislocation occur, and dislocation need not necessarily occur.

3. Primary hip dysplasia is due to a genetic background.

4. Roentgenographic consanguinity studies are essential for a true genetic investigation of hip dislocation.

5. There is no "dislocation" gene.

6. There is a "hip dysplasia" gene.

7. The gene involved is not a recessive gene, but is a dominant gene.
8. The trait of hip dysplasia cannot be sex linked, because it is observed to pass from father to son.
9. Dysplasia of the hip without dislocation is a distinct clinical and roentgenographic entity, and should be included in textbooks in the chapter on classical dislocation, because the two entities have the same genetic etiology.
10. Dysplasia of the hip without dislocation occurs more frequently and may be more disabling than classical dislocation.
11. Acclivity of the roof of the acetabulum is the primary anatomical feature of a dysplastic acetabulum or flat socket.
12. Hip dysplasia refers not only to the acetabulum, but also to all joint-forming parts of the hip joint.
13. Primary hip dysplasia can lead much more easily to complete dislocation in the female than in the male.
14. Primary hip dysplasia with dislocation on one side is frequently associated with dysplasia without dislocation on the opposite side.
15. Hip joint instability and incongruity between the head and socket are the physiological and anatomical expressions of hip dysplasia without dislocation.
16. Primary hip dysplasia may remain asymptomatic for many years; in some individuals it may never be expressed clinically.
17. The extreme disability observed in some individuals is caused by traumatic arthritis of the hip joint resulting from mechanical factors of instability and incongruity.
18. The patient may gain relief of pain and disability by conservative treatment and surgical measures.
19. The geneticist and the surgeon have a tremendous opportunity for cooperative investigation.

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The writer has quoted freely from the authors whose works are included in the references.

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REPAIR OF COMPLETE ACROMIOCLAVICULAR DISLOCATION, UTILIZING THE SHORT HEAD OF THE BICEPS *

BY LUTHERO VARGAS, M.D., RIO DE JANEIRO, BRAZIL

Orthopaedic Surgeon-in-Chief, Centro Médico-Pedagógico "Oswaldo Cruz", Rio de Janeiro

When there is an incomplete acromioclavicular dislocation,—that is, when only the acromioclavicular ligaments are ruptured—reduction can easily be carried out and maintained with non-operative procedures, such as immobilization in plaster for three weeks. In these cases, the clavicle generally stays in correct relationship with the acromion process of the scapula. If there is any dislocation, it is generally very slight. The majority of cases in everyday practice do not demand surgical measures.

When, however, there is complete dislocation with marked displacement, the conoid and trapezoid ligaments are most certainly ruptured; conservative procedures, under these circumstances, do not give satisfactory results. Surgical intervention is indicated to produce and maintain a stable joint with satisfactory function.

The purpose of this paper is to describe a surgical procedure for complete dislocation of the acromioclavicular joint. It was suggested in 1941 when a patient presented an unstable acromioclavicular joint following a complete dislocation, although three attempts had been made to produce a satisfactory joint by conservative measures. The author makes no claim for originality; in discussing the possibilities as to surgical repair with Dr. Mario Jorge de Carvalho, Head Surgeon of the Central Hospital for Wounded in Accidents (*Hospital Central de Accidentados*), he suggested the utilization of the short head of the biceps. It was decided to first perform this technique on a cadaver. Anatomical experiments proved that the short head of the biceps was easily available, and that it was sufficiently strong to withstand the required tension.

The technique of the procedure is as follows: A saber-cut incision is made over the anteromedial aspect of the shoulder, beginning two centimeters medial to the acromioclavicular joint and extending distally along the extremity for nine centimeters. The deltoid muscle is separated in the line of its fibers, visualizing the ruptured coracoclavicular ligaments. In fresh cases a hematoma will be present in this area. Upon exposure of the coracoid process, the short head of the biceps is split in half longitudinally for six centimeters, leaving its proximal end attached to the coracoid process. Distally, one-half of the tendon is incised transversely near the muscle fibers and this tendon slip is reflected proximally. A hole, eight millimeters wide, is then drilled in the clavicle immediately above the coracoid process. The new ligament is passed upward through this hole

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over the anterior edge of the clavicle and sutured to itself. A bone peg is driven into the hole to secure further fixation of the tendon.

After routine closure, the upper extremity is immobilized in a plaster-of-Paris cast, the arm being held against the chest for a period of twenty days.

CASE REPORT

M. H. T., a Brazilian, aged forty-nine, a stevedore, was examined on December 20, 1941. He had been injured one month previously when he fell from a ladder onto his outstretched right arm. There was immediate intense pain and impairment of function of the entire right upper extremity. Examination revealed complete upward and backward displacement of the outer extremity of the clavicle at the acromioclavicular joint,—the so-called Galen's dislocation. Obviously the acromioclavicular ligament and the conoid and trapezoid ligaments had been completely ruptured. Roentgenograms confirmed the clinical diagnosis.

Having undergone non-operative procedures with unsuccessful results, the patient requested surgical repair of the affected joint. On December 28, 1941 the technique described was carried out. Immobilization was discontinued in twenty days. This workman soon regained ample movements of the arm and was carrying on his activities as a stevedore six weeks after operation.

Roentgenograms on January 5, 1942, still showed some separation of the acromioclavicular joint. Despite this slight displacement, the patient is able to carry on his normal occupation as a stevedore, certainly a very strenuous one, without impairment of the use of his arm.

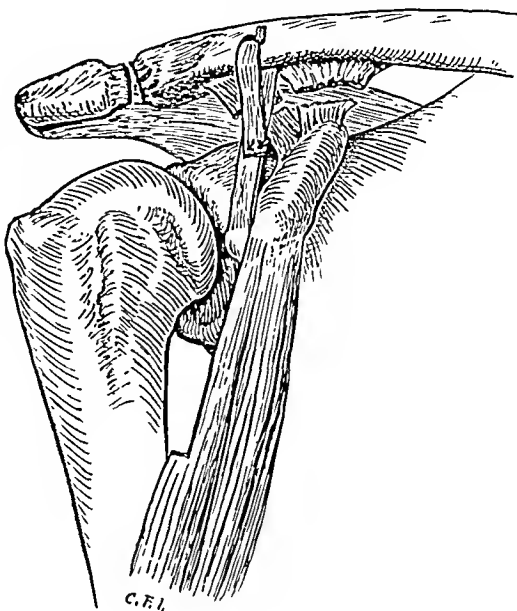


FIG. 1

SPASTIC SCOLIOSIS AND OBLIQUITY OF THE PELVIS

BY S. L. HAAS, M.D., SAN FRANCISCO, CALIFORNIA

From the Shriners' Hospital for Crippled Children, San Francisco

Scoliosis of the spine with pelvic obliquity, due to spastic paralysis, is an infrequent clinical entity. The correction of this deformity is difficult because of the complicated causative mechanical factors, the disorganization of normal muscle control, incoordination, and disturbance in equilibration. It is important that, in attempting a correction of this deformity, one does not further disrupt locomotion by increasing the imbalance or enhance the ability of accommodation for coexisting deformities.

In the treatment of spastic contracture in general, a number of opera-



FIG. 1-A



FIG. 1-B

Patient standing before operation.

an associated obliquity of the pelvis, which was high on the right and low on the left side. The knees were held in flexion, the left more than the right, to accommodate for the pelvic shift. The left foot was in a marked valgus position and there was considerable instability in the right foot. The photographs (Figs. 1-A and 1-B) show the patient standing. The roentgenogram (Fig. 2) shows the scoliosis of the spine and the obliquity of the pelvis.

On February 12, 1940, the flexion and internal rotation contractures were treated by a combined Soutter and Durham release of the flexors and internal rotators of the hip joint. The tight abductors were severed by an open tenotomy.

A Kirschner wire was inserted through the upper end of the crest of the tibia, and both lower extremities were encased in plaster from the toes to the groin. A Carl Jones splint was applied, and, after healing was complete, the pelvic obliquity and scoliosis could be corrected by pushing up on the left side and pulling down on the right. After the apparatus was released the deformity returned to the original proportions.

The problem that presented itself was to maintain the correction of the deformity. The following methods were given consideration before a decision was reached:

1. Fusion of the spine. This would have to include the sacrum with the lumbosacral joints, and all the lumbar vertebrae. In view of the bad results obtained with this type of fusion in cases of poliomyelitis, it was thought to be particularly inadvisable in spastic paralysis. A constant strong unilateral pull may cause a return of the deformity with permanent fixation. A spastic patient with disturbance in equilibration may need the free movement of the spine and pelvis to maintain his balance.

2. A strut graft from the ilium to the rib cage on the side of flexion, in conjunction with fusion or other procedures, would have the same limitations as spine fusion,—too much fixation and difficulty of maintaining the correction if the operation was successful.

3. The release of the spastic sacrospinales, lateral and anterior abdominals, and quadratus lumborum would entail an extensive dissection, a difficult problem of balance of pull, and the possibility of herniation and other bad sequellae.

4. Neurectomies or other nerve-destroying operations to the involved muscles were not considered advisable because of the possibilities of the last method.

5. Fascial slings or checks from the ribs to the pelvis on the opposite side, as have been used in poliomyelitis, may be successful. The opposing strong constant pull would tend to stretch the fascia unless a compensatory hypertrophy of the fascia took place. There was also the difficulty of completely fixing one half of the pelvis.

6. The greater pull of the spastic muscles on the right side over the normal muscle pull of the muscles of the left side was considered to be responsible for the scoliosis and the obliquity of the pelvis. If some of the pull of the anterior and posterior muscles could be transferred to the opposite side and the correct balance obtained, the deformity could be permanently corrected. As the deformity could be actively corrected by the use of the Carl Jones splint, it was known that no permanent structural changes had taken place. If the method did not work, then some of the

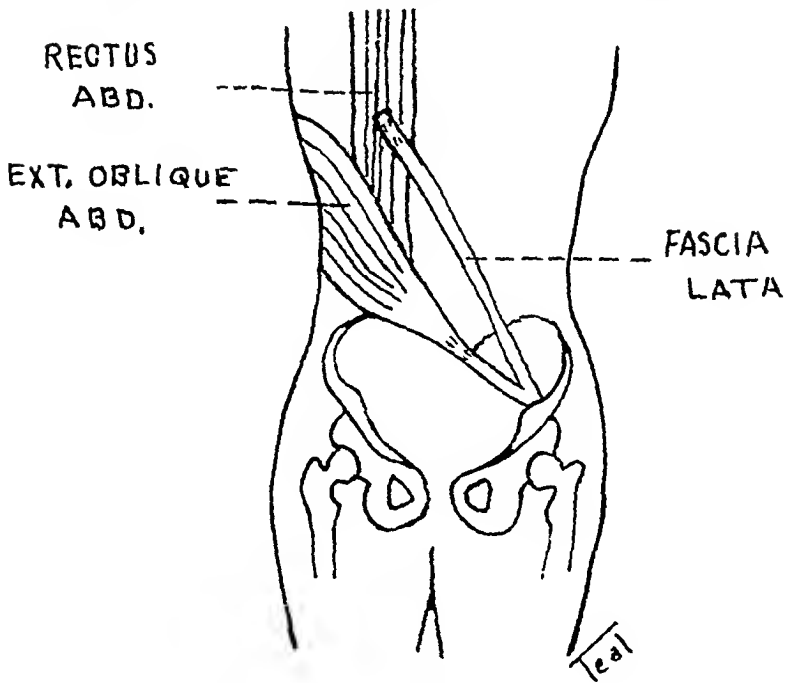


FIG. 3-A

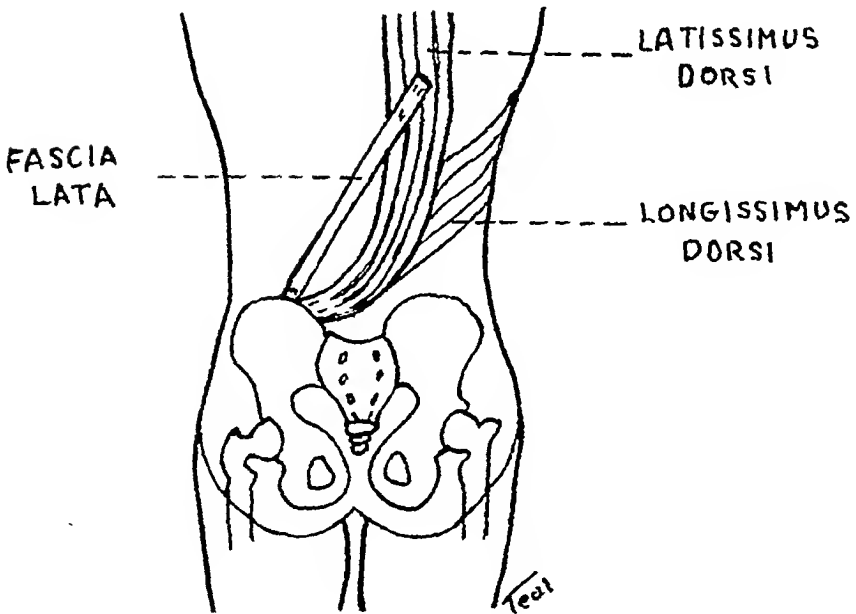


FIG. 3-B

Showing the transference of the muscles of the abdomen and of the back.

other methods could be utilized to supplant any deficiency. Accordingly the following operations were performed on the patient.

Operation

The scoliosis and obliquity of the pelvis were corrected by the Carl Jones apparatus. The flexion, internal rotation, and adductor deformities had been previously corrected by operation.

On May 1, 1940, a portion of the right obliquus externus abdominis with fascial prolongation was transferred into the left side of the ilium near the anterior superior spine, and a fascial sling was made between the right rectus abdominis and the left anterior superior spine as follows:

1. An incision was made along the crest of the ilium on the right side and dissection was carried down to the iliac crest. The overhanging muscle was retracted upward, after which an incision was made through the periosteum. Dissection was carried down along the inner side of the ilium, freeing the iliacus which was allowed to retract to help relieve the flexor contracture of the hip. The periosteum was stripped off the ilium upward, taking with it the obliquus externus abdominis. About one-third of the obliquus externus abdominis was then separated from the remainder of the muscle. A piece of fascia lata, which had been previously removed from the left leg, was sutured to the free end of the obliquus externus abdominis. This fascia lata prolongation of the obliquus externus



FIG. 4-A



FIG. 4-B

November 8, 1941. Patient standing one year and five months after operation

abdominis was passed across the abdomen in the subcutaneous fat to an incision made in the region of the anterior superior spine on the opposite side. The fascia was then passed through a hole drilled through the crest of the ilium at this place, turned back upon itself, and anchored with interrupted silk sutures. There was a little excess of fascia lata which was utilized in the second part of the operation.

2. An incision was then made over the junction of the upper and middle thirds of the right rectus abdominis. A second incision was made over the left rectus abdominis at a lower level,—in line with the anterior superior spine. An additional piece of fascia lata, which had been removed from the left thigh, was passed through the sheath of the right rectus abdominis and through a portion of the muscle, and then anchored to itself and the muscle with interrupted silk sutures. The free end was passed across the mid-line in the subcutaneous fat to the incision over the left rectus abdominis, where it was passed through the sheath and some of the muscle. Several interrupted silk sutures were inserted at this place. The fascia end was then brought down toward the left anterior superior spine, where it was sutured with interrupted silk sutures to the redundant piece of fascia lata from the first part of the operation, and also to the anterior superior spine of the left ilium (Fig. 3-A). The wounds were brought together with interrupted chromic sutures for the fat and fascia,

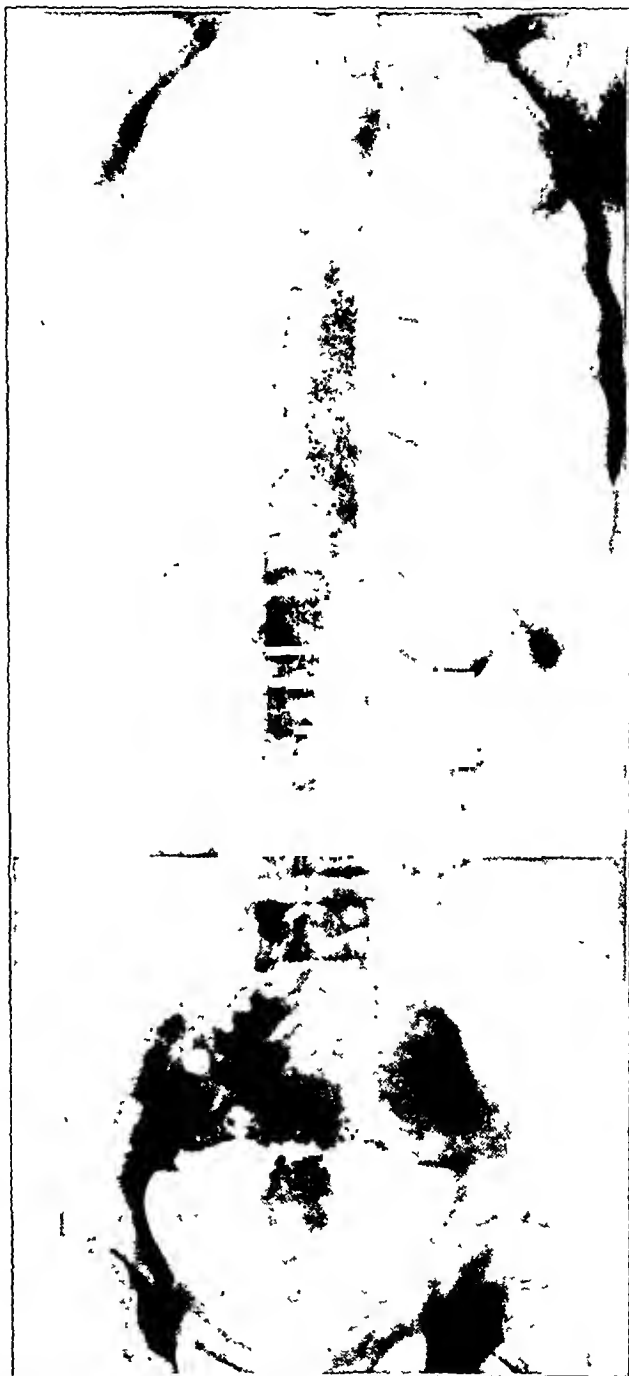


FIG. 5

June 11, 1942. Roentgenogram taken two years after operation, showing the correction of the spine and the obliquity of the pelvis.

and with silk sutures for the skin. A body jacket and left leg spica were applied, with the left extremity in abduction.

On June 1, 1940, the plaster casts were removed from the lower extremities preparatory to the second series of operations.

On June 5, 1940, the patient was placed face down on the operating table.

1. An incision was made over the upper portion of the iliocostalis lumborum. A piece of fascia lata, which had been removed from the left thigh, was anchored to the muscle and the overlying fascia of the latissimus dorsi with interrupted silk sutures. The strip of fascia was then passed diagonally downward in the subcutaneous tissue to an incision in the region of the posterior portion of the crest of the ilium, where it was anchored interosseally.

2. The sacrospinalis was exposed at its origin on the sacrum and the ilium, and a portion of the longissimus dorsi and iliocostalis were freed with the overlying fascia. The raised-up muscle was transferred to the region of the posterior superior spine of the ilium of the opposite side, and was anchored with interrupted silk sutures (Fig. 3-B). The wounds were sutured with interrupted chromic for the deep layers and with silk for the skin. A double plaster spica was applied on completion of the operation.

On June 28, 1940, both feet were stabilized by a Hoke type of operation.

On August 20, 1940, walking with crutches and a short leg plaster was started, the spica having been previously removed. He was discharged from the Hospital on September 25, 1940, walking with long leg braces, which he continued to use until May of 1941. He then used a cane to assist him in walking.

Examination on May 1, 1941, showed a little shift of the body to the left when he walked, but as he stood, the pelvis appeared well balanced. There was no scoliosis.

On November 8, 1941, about one year and five months after the muscle transferences, as he stood, the spine appeared straight, but when he walked, the right side of the pelvis was elevated a small amount. The bands of muscle were visible beneath the skin. There was three-quarters of an inch of real shortening of the right lower extremity, and this was compensated by a lift on the shoe. He was showing gradual slow improvement in his gait and balancing powers. The photographs taken from the front and back are shown in Figures 4-A and 4-B.

At the last examination, March 19, 1942, about one year and nine months following the final operation, the correction of the deformity was found to be fully maintained.

DISCUSSION

Spastic scoliosis and pelvic obliquity can be corrected and maintained by the proper muscle transference operation. It is important to obtain a balancing of the muscle pull on both sides of the pelvis and rib cage.

It is possible that the same type of correction could be secured in early paralytic scoliosis before fixed contracture and structural changes had taken place in the vertebrae. It would be necessary to know definitely which group of muscles are involved before any muscle transference operation could be performed. Unfortunately, it is not easy to determine this fact in many cases of scoliosis.

Transference of muscles in association with fusion operations may help to reduce the loss of correction and the tendency to recurrences following fusion operations for scoliosis of the spine.

THE INFLUENCE OF SODIUM-BETA-GLYCEROL-PHOSPHATE UPON THE HEALING OF EXPERIMENTAL FRACTURES *

BY LOUIS SPERLING, M.D., W. D. ARMSTRONG, M.D., AND
SIDNEY LITOW, M.D., MINNEAPOLIS, MINNESOTA

From the Department of Surgery and the Division of Physiological Chemistry, University of Minnesota, Minneapolis.

The study of the reparative processes following fracture of bone has been the subject of intensive study. While the cytological changes are fairly well understood and have been described by many workers, the exact chemical processes involved are still not entirely clear.

In 1923 Robison discovered that bone contains a ferment which he called phosphatase. This enzyme hydrolyzes available phosphoric esters and increases the concentration of phosphate ions beyond the level of solubility of calcium phosphate, so that the salt is deposited in the callus. There is no conclusive evidence that delay in the healing of fractures, or calcification of the hematoma, is due to a quantitative deficiency of phosphatase¹; nor is there any evidence that the delayed healing is due to absence of sufficient mineral salt at the site of the fracture. Urist recently stated that the bone salt originating locally in necrotic bone or implanted in the callus is absorbed without influence upon the progress of calcification of the new bone and cartilage matrix.

The humoral source of bone salt is essential for the normal process of healing, and, according to Urist, cannot be entirely replaced by local sources of mineral without considerable delay in the uniting of fractures.

The erythrocytes contain an abundance of phosphoric esters hydrolyzable by phosphatase², but the plasma, while containing normally a sufficient concentration of calcium, contains only minute amounts of ester phosphorus hydrolyzable by phosphatase,—two-tenths to five-tenths of a milligram of phosphorus per 100 cubic centimeters³. It appears possible that one of the factors limiting the speed of the process of calcification is the low content of plasma in this substance essential to the precipitation of calcium in callus, and in new-bone formation. It seemed desirable, therefore, to investigate the effect of the intravenous injections of sodium-beta-glycerol-phosphate on the rate of healing of fresh experimental fractures. As far as can be determined, this ester of phosphoric acid has not previously been used in experimental or clinical studies on the healing of fractures.

METHOD

The right radius of rabbits, weighing between four and one-quarter and four and three-quarters pounds, were fractured under ether anaesthesia. The fractures were produced by grasping the middle of the shaft

* This work was supported by Grant 577 of the Committee on Scientific Research of the American Medical Association and by the Graduate School of the University of Minnesota.

of the bone between two adjacent and parallel Kocher forceps and exerting steady force in opposite directions until the bone was fractured. A few animals, in which breaks of both the radius and ulna were produced, or which displayed marked bruising of the skin or compounding of the

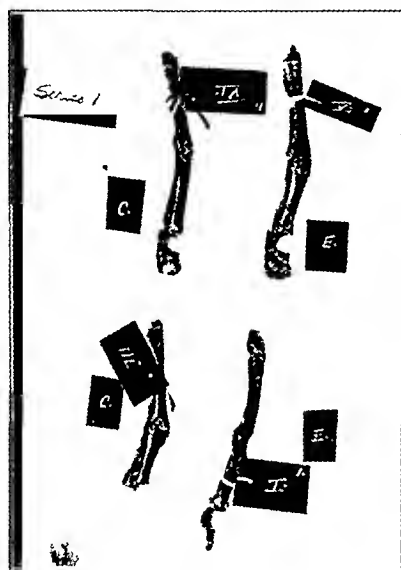


FIG. 1-A



FIG. 1-B

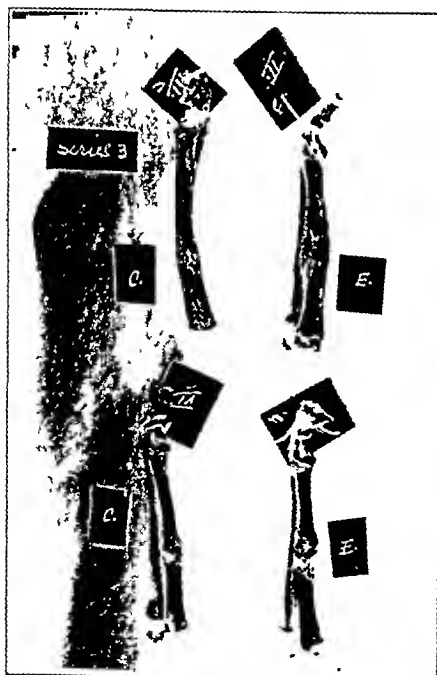


FIG. 1-C



FIG. 1-D

Photographs of fractures of rabbits' radii of nine to fourteen days' duration.
E.: Experimental animals which were given daily injections of sodium-beta-glycerol-phosphate.

C.: Control animals, given daily injections of physiological normal saline.

fracture, were discarded. Roentgenographic examination revealed that the fractures usually were transverse, and that the fragments were in alignment with little comminution of the bone. The undamaged ulna served as an effective splint and the animals were able to use the limb upon recovery from the anaesthesia.

Twenty-seven animals of the experimental group received six to fourteen daily injections, by ear vein, of one-tenth of a gram of sodium-beta-glycerol-phosphate in four cubic centimeters of solution. Twenty-two animals with similar fractures served as controls, and received a like number of injections of four cubic centimeters of physiological saline. All rabbits were sacrificed the day following the last injection.

RESULTS

Roentgenograms of the limbs, taken before and after removal of the soft tissues, revealed an increase in callus about the fracture site in the group treated with sodium-beta-glycerol-phosphate. The fracture callus of the animals receiving eight to fourteen treatments with sodium-beta-glycerol-phosphate was greater in amount and more firm to palpation than that of the control animals. After cleaning the bones, it was noted that, even though some of the callus was lost when the periosteum was removed, the healing of the fracture appeared to have progressed further in the animals treated with sodium-beta-glycerol-phosphate. The hard

callus of the treated animals was larger, and the fracture defect was more nearly bridged over, than in the controls.

In the treated group it was noted, on stripping the periosteum, that much callus was adherent to the periosteum; while in the untreated group the periosteum stripped off easily with no adherent callus. Examples of the different stages of progress in healing of the fractures of animals treated with sodium-beta-glycerol-phosphate and with physiological saline are shown in Figures 1-A, 1-B, 1-C, and 1-D. A more objective means of estimating the degree of union

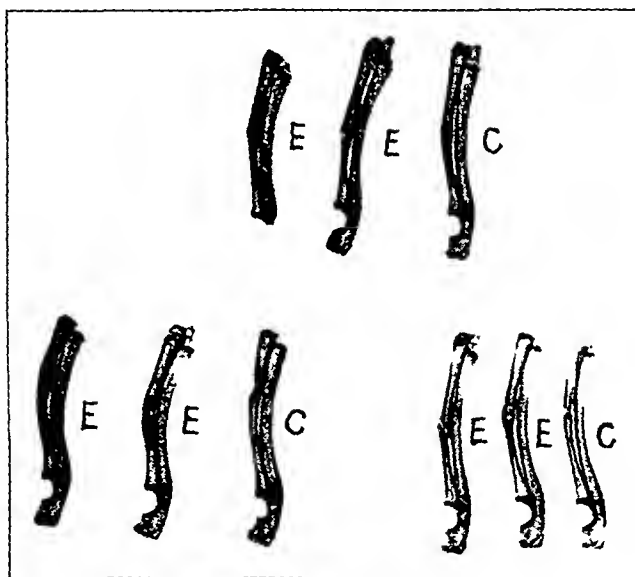


FIG. 2

X-rays of fractured radii of rabbits after ten days. Note the greater amount of callus in experimental animals.
E.: Experimental animal. C.: Control animal.

phate and with physiological saline are shown in Figures 1-A, 1-B, 1-C, and 1-D. A more objective means of estimating the degree of union

would be desirable. Further experiments are in progress and will be reported later. The authors' observations indicated that the drug, in the majority of cases, exerted a positive effect, even though the fractures with which the authors were dealing normally progress to rapid healing. Four determinations of serum inorganic phosphate and calcium, made at regular intervals during the course of twelve daily injections of one-tenth of a gram of sodium-beta-glycerol-phosphate into rabbits, showed no consistent differences from the results obtained with untreated animals.

STUDIES ON TOXICITY OF SODIUM-BETA-GLYCEROL-PHOSPHATE

Sodium-beta-glycerol-phosphate, when given by intravenous injection over a long period of time or in large doses, is not toxic. The liver, intestine, urinary bladder, kidney, heart, and aorta of all experimental animals were normal grossly and microscopically, as were those of a rabbit which received fifty-five daily injections of one-tenth of a gram of the drug. Similar results were obtained with three rabbits following six daily intravenous injections of one gram of the substance. No symptoms were produced following twenty-six daily subcutaneous injections of one-tenth of a gram of sodium-beta-glycerol-phosphate into a rabbit, and no pathological findings were noted at autopsy. A dog weighing seventeen kilograms received ten daily intravenous injections of ten grams of the substance in forty cubic centimeters of solution. No ill effects were produced, and when the animal was sacrificed, two months after the last injection, no pathological alterations of any organ were observed. Massive doses (twelve to twenty-four cubic centimeters of a solution containing 0.25 gram of the substance per cubic centimeter) were fatal in two to five days when given each day to rabbits by intraperitoneal injection. This was probably due to the administration of a massive hypertonic solution.

CONCLUSIONS

Sodium-beta-glycerol-phosphate is an innocuous drug,—readily available for further experimental and clinical studies. It is apparently well tolerated by the experimental animal in a dosage of wide range, and seems to stimulate and hasten the reparative process and the production of bone callus. More histological and chemical studies are in progress. The clinical trial of sodium-beta-glycerol-phosphate is suggested.

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IMMERSION FOOT *

BY SURGEON COMMANDER D. R. WEBSTER, SURGEON LIEUTENANT F. M. WOOLHOUSE, AND SURGEON LIEUTENANT J. L. JOHNSTON, HALIFAX, NOVA SCOTIA, CANADA

"Immersion foot" is the name used to denote a condition produced by long immersion of the feet in extremely cold water, usually associated with immobility of the limbs and constriction of the limbs by boots and clothing. This is a similar condition to "trench foot" and "shelter foot" (described by Knight), but until this war it has received little study by naval surgeons.

We have had the opportunity to observe 142 of these cases, almost all the result of enemy action in the North Atlantic. The patients had been in lifeboats or rafts for periods varying from thirty hours to twenty-two days, the boats almost always containing water to a depth of several inches in spite of constant bailing. The only recorded temperatures of the water showed it to be from 34 to 36 degrees Fahrenheit, and, as the freezing point of sea water is approximately 28.5 degrees Fahrenheit, the feet may well have been exposed to surface cooling below the freezing point of blood, which is 31 degrees Fahrenheit.

At the time of removal of the patients from the open boats or rafts, the feet were cold, swollen, and waxy white in color, with scattered cyanotic areas. The patients complained at that time that their feet felt heavy, "woody", and numb, and the feet were anaesthetic to pain, touch, and temperature.

Shortly after removal of the feet from this traumatizing environment, the swelling increased rapidly as the feet became red, hyperaemic, and hot without sweating, and the pulse in the vessels of the feet was full and bounding. In those more severely damaged areas—usually the toes, the distal part of the dorsum of the foot, and the ball of the foot—the parts remained oedematous and hot, and assumed a livid, cadaveric appearance. A number of these latter areas later produced blebs, some of which were filled with straw-colored fluid and others with extravasated blood; and areas of ecchymosis commonly appeared over the medial aspect of the first metatarsophalangeal joint and on the medial aspect of the longitudinal tarsal arch. Many of these feet presented the appearance of incipient massive gangrene. The rapid swelling and increasing redness, accompanied by the extreme rise in temperature of the part, presented the picture of an intense vasodilatation, accompanied by definite damage to the vascular wall with transudation, as manifested by bleb formation and extravasation of blood.

The anaesthesia followed a variety of patterns. In the mildest cases these areas extended around the margins of the foot and over its plantar

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aspect, being of greater extent along the lateral border where the mass to surface ratio is smallest. In the more severe cases these areas extended over the entire dorsum of the foot, and in some cases over the lower two-thirds of the leg. Patches of anaesthesia over the knees in the prepatellar and infrapatellar regions were observed in two cases where there had been prolonged kneeling in the lifeboats.

A similar picture was recently observed by one of us (D.R.W.) among survivors landed at the Marine Hospital at Norfolk, Virginia. These men were in the Gulf Stream where the water was between 60 and 70 degrees. Cold could not have been a factor there, but immersion of the feet in sea water over a period of eight days resulted in gangrene and sensory changes similar to those observed in the Halifax series, in which cold was an indubitable factor in the production of immersion foot.

In all cases treated, the initial anaesthesia and hypaesthesia were replaced by intense paraesthesia on the eighth to tenth day after removal from the traumatizing agent. The paraesthesiae were described as, first, an intense burning sensation over the surface of the entire foot, persisting for approximately one day; this was then replaced by an intense, intermittent, stabbing, shooting pain, which commenced in the ankle joint or the midtarsus and radiated to the tips of the toes, with a generalized tingling sensation in the foot during the interval between the stabbing pains. The paraesthesiae subsided as they gradually receded distally to the metatarsal pad and the pads of the toes. This process occupied a period of from three to four weeks, persisting longest in the older men with arteriosclerotic changes apparent in the radial artery at the wrist.

Because of the picture of intense vasodilatation with transudation of serum and of blood, and the subsequent profound inflammatory reaction with its concomitant increase in the metabolic demands of the tissues involved, a clinical trial of treatment of "immersion foot" by dry refrigeration was made at Camp Hill Hospital, Halifax, Nova Scotia.

The tragic results from too rapid warming of these feet have been so frequently demonstrated that it is only mentioned for emphasis.

A considerable literature on the effect of low temperature on tissue survival has accumulated. According to Freeman, "Gangrene results from a discrepancy between the demands of the tissues and the supply of blood to meet these nutritional needs", and, in reporting on the development of gangrene in peripheral vascular disease, he stated the belief that the affected part should be kept at a temperature of from 30 to 34 degrees. Starr likewise concluded that maintenance of temperature between 30 and 40 degrees is most favorable for increasing circulation and inhibiting oxidation.

Brooks and Duncan, experimenting with rats' tails, stated that temperature is a powerful factor in determining the length of time that tissue rendered anaemic remains viable. Allen, working with loops of intestine rendered ischaemic by ligation or tourniquet, found that gan-

grene occurred in from three to three and one-half hours, if temperature was kept at from 40 to 41 degrees Fahrenheit, but did not occur in fifty-four hours if the temperature was kept at from 0 to 2 degrees centigrade. Lewis' classical work likewise demonstrated that tissue remains viable at temperatures well below freezing.

Greene, in his extensive experience with frostbite, concluded that the trauma of immersion foot is similar to that of frostbite or shelter foot, stating that "it is difficult to see how treatment producing vasodilatation could possibly do anything but harm in the acute stage".

Smithwick and White have recorded the beneficial effects of sympathectomy in saving tissue and in relieving pain in peripheral vascular disease. In immersion foot, however, the sympathetic supply to the feet appears to be absent, as indicated by the lack of sweating in the affected parts, by the vascular sensitization to adrenalin demonstrated in our cases by Lieutenant Commander J. C. White, U.S.N., and by the fact that the temperature of the feet is higher than that usually associated with sympathectomy. Therefore, no advantage would be gained by ganglionectomy, as suggested in a number of articles in the French literature (Soupault and Orsoni, Simon and Filhoulaud, Forster and Wiederkehr, and Stricker and Buck).

There appears to be a marked variation in the individual response to this form of trauma. Knight has attributed this in part to a nutritional deficiency. We have observed in our series that those who suffered the most severe damage were Greeks, Australians, negroes, and those employed in engine-room or stokehold duties. This suggests that those accustomed to a warm environment may not have the same defences as those who have been exposed to colder climates.

CLINICAL TRIAL OF TREATMENT

The following is an initial report of the clinical trial of treatment mentioned earlier in the paper:

Classification of Immersion Foot

This condition was classified in four groups, as follows:

- I. Minimal case: that showing only erythema with slight sensory changes.
- II. Mild case: that showing pitting oedema, erythema, and sensory changes.
- III. Moderate case: that showing pitting oedema, erythema, blebs, and ecchymotic spots.
- IV. Severe case: that showing gross pitting oedema, blebs, massive extravasations of blood, and incipient gangrene.

Classified in this manner, the cases treated were distributed as follows:

<i>Group I</i>	<i>Group II</i>	<i>Group III</i>	<i>Group IV</i>
39 cases	38 cases	50 cases	15 cases

Method of Treatment

The methods of refrigeration used were those which could be applied expeditiously with the facilities at hand, and do not represent ideal methods of employing dry cold. Apparatus is being constructed which will produce uniform dry cold, and the results of the use of this apparatus will be reported later.

Dry cooling and refrigeration were achieved in the present series by the following means:

A. *Application of ice bags*: The traumatized feet were carefully swabbed off with alcohol; sterile pledgets of gauze were placed between the toes; and the whole foot in each case was covered with a sterile towel. During this procedure the feet were handled as little and as gently as possible. Five carefully dried ice bags were placed around each foot over the towel, and the whole enclosed in an oiled-silk bag. This was then wrapped in thick layers of cellucotton, and enclosed in rubber pillowcases loosely tied about the upper calf of the leg. The feet were then elevated on several pillows. The ice bags were changed every four hours except in those cases of extreme hyperaemia in which more frequent changing was necessary to result in an average lowering of the temperature of the foot of about 6 degrees centigrade.

B. *Dry cooling by exposure to fan*: The feet were exposed and elevated in front of electric fans, which drove a continuous blast of air across the traumatized areas. To enhance cooling, the feet were repeatedly sprayed through the fan blades with cold water from a nebulizer.

C. *Dry cooling at room temperature*: The feet were elevated and completely exposed to room temperature in a cool ward.

Skin temperatures were taken with a dermaterm three times a day over four areas of the feet, as indicated by Figure 1.

Results of Treatment

Within a few hours after application of the ice bags, the patients were completely comfortable. The oedema rapidly subsided to such an extent that in many cases the skin was wrinkled at the end of four hours. This cannot be due to posture alone, because it has been observed repeatedly that the oedema returns when the ice bags have been removed for as short a time as thirty minutes.

The two varieties of blebs described—those filled with straw-colored fluid and those filled with extravasated blood—were resorbed without breaking. These blebs refilled if the ice was discontinued prematurely, but became resorbed again when the ice was reapplied.

All patients in Groups I, II, and III, with one exception—a patient who succumbed following the development of empyema and staphylococci septicæmia—recovered completely after superficial desquamation over the entire foot and a brief period of reeducation necessitated by an abnormal gait. The average period of hospitalization of these patients was 30.4 days.

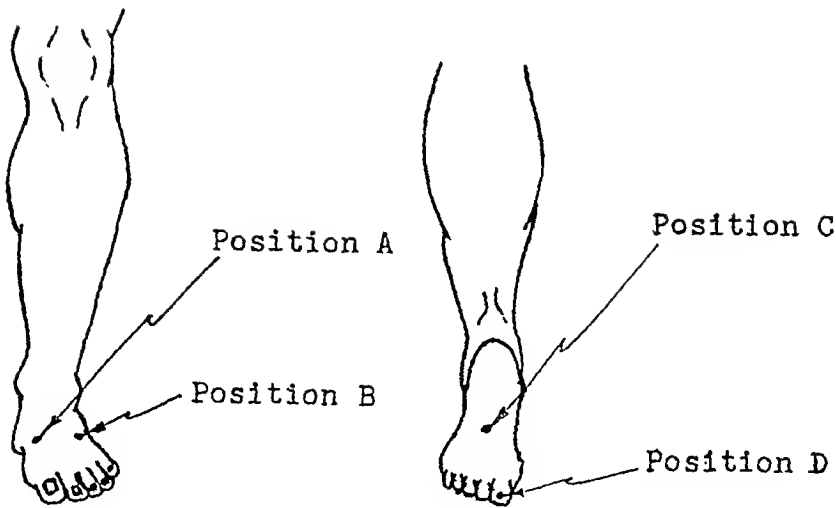


FIG. 1

Of the fifteen patients in Group IV, seven have been discharged from the Hospital after the loss of small areas of superficial tissue, which healed rapidly and did not require grafting. The remainder are still confined to the Hospital. In five of these cases, gross tissue defects have developed across the mid-dorsum of both feet, which in the early stages of the condition represented the final demarcation of normal and damaged tissue. In two of these cases (D. K. and H. C.) the defect appeared as a band encircling the foot, beyond which the tissues seemed healthy, but infection supervened and led to gangrene in the distal portion of the foot. Passive vascular exercise by means of the paevex boot was used in some cases, but no benefit from this treatment was noted. In two cases, the superficial skin over the distal aspect of both feet has become mummified and is being shed, leaving healthy tissue with epithelial islands throughout.

In one case (D. R.), in which ice bags were applied for four weeks, the tissues of the feet assumed a healthy pink color, and the ice bags were removed. The feet were permitted to return to room temperature, and within eight hours a large quantity of blood was extravasated into the subcutaneous tissues. The feet became greenish-gray in color, with a sharp line of demarcation between healthy and damaged tissue encircling the mid-tarsal region of both feet, and tissue breakdown occurred. This will progress ultimately to extensive tissue loss over the distal aspect of both feet.

One patient (R. B.), in the group still hospitalized, suffered severe contusions of the lower legs while transferring from a lifeboat to a rescue ship, after the development of immersion foot. He was admitted to the Hospital with his legs grossly swollen and hyperaemic, and the skin over the distal third of each leg and foot was livid. On the fourth day of his hospitalization the patient became extremely ill, and tenderness

and enlargement of the liver developed. This was followed in twenty-four hours by the onset of pneumonitis and acute pulmonary oedema. Recovery from these complications was slow, but, during the entire time, the oedema in the feet and legs subsided with gross wrinkling of the skin over the feet. The skin over the heels and across the proximal dorsum of the feet became macerated and mummified, and is now being shed, leaving healthy granulations. A tendency to drop-foot is being corrected by mechanical means.

In the cases of D. P. and C. Y. F., infection and cellulitis developed from a focus of epidermophytosis at the base of the fifth toes. These patients were treated with sulphathiazole by mouth, and, while the infection subsided, loss of tissue occurred, necessitating, in the case of C. Y. F., the amputation of the left great toe at the metatarsophalangeal joint, both fifth toes, and the left third toe at the proximal interphalangeal joint.

In the case of P. N., originally treated with ice bags and then by constant fanning, a dry gangrene developed in the left foot, which progressed to involve the foot to the mid-tarsus. Amputation of the left foot at the site of election was performed after thirty-four days' hospitalization. The patient's right foot has recovered completely with loss of superficial epithelium.

Large doses of vitamin B₁ failed to alleviate the neuritic pains, and, in some cases, the patients complained that their distress was increased shortly after the administration of the drug.

It is noteworthy that the application of ice bags in these cases, whether or not the patients had been treated initially with ice, relieved the severe pain in about an hour. In some cases in which the weight of the ice bags was intolerable, the patients made voluntary effort to cool the feet by putting them in the open windows of the ward.

In five cases, pain and redness occurred along the course of the veins on the dorsum of the feet; and in one case, along the course of the saphenous veins in both thighs. In the first five, there were showers of petechiae in the juxtaposed skin. In two cases, segments of the veins were palpably thrombosed, but in no case was there noted an accompanying febrile reaction. This complication appeared with about equal frequency in those patients treated with ice bags and in those not so treated.

In a large number of those cases in Groups II, III, and IV, following the disappearance of the paraesthesia and the voluntary assumption of up-privileges, the patients were found to have a grossly altered gait. They first walked with a slapping, flat-footed, springless gait, which gradually improved in about seven days. At the end of this period they had regained normal "take-off" from the toes, and were able to stand on tiptoe without undue effort or discomfort. In two cases a transient bilateral paresis of the fourth and fifth toes was noted, recovery taking place in seven days. Follow-ups on many of these patients proved that



D. R. Showing condition on admission.



D. R. After seven days of ice-pack treatment.



R. D. On admission.



C. Y. F. On admission.



H. C. After seven days of ice-pack treatment.



H. S. After seven days of ice-pack treatment.

pain recurs if the feet are subjected to cold and wet, or if long walks are undertaken.

In one case a transient hematuria and albuminuria occurred and persisted for forty-eight hours. Also, three patients had a generalized toxic febrile reaction with enlargement and tenderness of the liver during their first week of hospitalization. It is noteworthy that in this group of survivors, exposed to the elements for from one to twenty-three days, upper respiratory infections occurred in only two cases. In all of the cases in which the patients were hospitalized within a few hours of rescue, there was a very appreciable febrile reaction, the average temperature rise being to approximately 100.5 degrees; in most cases under observation this temperature subsided in the first twelve to thirty-six hours of hospitalization.

DISCUSSION

The rationale of this treatment rests on the presumption that the tissue damage caused by the original trauma results in an intense vasodilatation, together with actual damage to the vessel walls and damage to peripheral nerves or end organs. A vicious circle is thus established, with a resulting oedema and transudation of serum and blood, all of which further contribute to the already present oxygen debt in the involved part. This latter, in turn, leads to an increase in oedema and transudation of whole blood. It was believed that, if the metabolic demands of the part—which, of course, are great, because of the reaction to tissue injury with the concomitant rise in local temperature—could be reduced until the oedema subsided, the extravasated blood was reabsorbed, and the vasomotor tone was reestablished, the tissue damage would be greatly ameliorated. At present it is not known how much of the fluid loss from the vessels is due to actual damage to the vascular wall, and how much is due to the loss of neurogenic control of the vessels.

Strict asepsis is essential in handling these cases because in those patients in whom infection developed in the damaged tissues of the feet, the infective process spread with great rapidity through all layers of the feet. This process was observed to occur in some cases without apparent break in the skin surface. The heels are also prone to severe tissue damage, due to pressure, and should be carefully guarded by means of padded rings or suspension apparatus.

In the series of cases studied, no cases of extreme emaciation were seen, and all patients desired and tolerated a normal full diet from the time of admission to the Hospital. We observed no sign of acute vitamin deficiency, such as stomatitis, cheilosis, hemorrhages, or visual disturbances, which were noted in the survivors landed at Norfolk. Dehydration was not a complicating factor in the present series, as these men were survivors of sinkings by enemy action in the waters of the North Atlantic and had a plentiful fresh-water supply and were not exposed to tropical heat at any time.

From our clinical observations and from the small amount of histological material available, it is apparent that there is an extending thrombosis in the vessels adjacent to the traumatized area. It is suggested that heparin would be of value in the early cases of Group IV. Our experience in the use of heparin is limited, but we believe that in one case presenting a clinical picture of vascular occlusion, heparinization was responsible for saving the involved limb. In tissues irreparably damaged, we believe that dry refrigeration, while postponing the inevitable gangrene, leads to a minimal tissue loss.

There are many unsolved problems in the study and treatment of immersion foot,—such as nerve dysfunction, vascular damage, the formation of H substance, and remote toxic effects.

SUGGESTED PROPHYLAXIS

Boots and any constricting footwear, if wet, should be removed, and oil or heavy grease should be generously applied to the feet while the seaman is exposed.

It is suggested that on rescue the patient should be lifted, if possible, and not be permitted to walk. No massage should be attempted, and the feet should be exposed and elevated and the patient given supportive treatment.

In the hospital strict asepsis should be maintained, and the feet should be cooled, if possible, during the hyperaemic period.

SUMMARY

1. This report is based on the observation of 142 cases of immersion foot at Camp Hill Hospital, Halifax, Nova Scotia.
2. This condition may occur in those exposed for long periods in subtropical waters and thus cannot be classed as a true frostbite.
3. Sensory loss and hyperaemia appear first and are followed in about ten days by intense neuritic pains, and, in severe cases, by varying degrees of gangrene.
4. Dry refrigeration appears to be successful in reducing tissue loss to a minimum.
5. Return of sensation and complete motor control may be delayed for many weeks, and pain may recur on exposure to cold and wet.
6. First aid and hospitalization should be directed to avoidance of trauma, slow warming of affected limbs, strict asepsis, and adequate supportive treatment.

We are indebted to the Department of Pensions and National Health for segregating these cases for our observation and study, to Surgeon Lieutenant D. Y. Solandt, R.C. N.V.R., for much valuable aid, and to Lieutenant Commander J. C. White, U.S.N., for many helpful suggestions. We are also grateful to the staff of The Marine Hospital, Norfolk, Virginia, for the generous demonstration of their cases.

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LOCALIZED FIBROCYSTIC DISEASE OF BONE

RESULTS OF TREATMENT IN ONE HUNDRED AND FIFTY-TWO CASES * †

BY RUFUS H. ALLDREDGE, M.D., NEW ORLEANS, LOUISIANA

*From the Department of Surgery, Division of Orthopaedic Surgery,
Tulane University Medical School, New Orleans*

More than six years ago a study of the different forms of fibrocystic disease of the bones was undertaken by the writer, on a series of cases collected from various sources. That study, carried out at the Hospital for the Ruptured and Crippled (now the Hospital for Special Surgery) in New York under the direction of P. D. Wilson, M.D., and staff, included a clinical, roentgenographic, and pathological survey of 152 cases of localized fibrocystic disease, or the so-called bone cyst.

Forty-eight of these cases were found in the records of the Hospital for the Ruptured and Crippled, and had been treated by different members of the staff over a period of about twenty-five years. Twenty-six were from the Bone-Tumor Service of B. L. Coley, M.D., at the Memorial Hospital, and fifty-three cases were taken from the Registry of Bone Sarcoma of the American College of Surgeons. The other twenty-five cases were obtained through the courtesy of individual surgeons: R. D. Schrock, M.D., and H. F. Johnson, M.D., of Omaha, A. R. Shands, Jr., M.D., of Wilmington, and P. C. Colonna, M.D., of Oklahoma City, contributed most of these. Great care was necessary so as not to duplicate these cases, since many of the cases from the hospitals and from individuals were on record in the Registry of Bone Sarcoma of the College of Surgeons.

The purpose of this paper is to present very briefly a summary of the end results of the different methods of treatment used in this group of cases. The various methods of treatment used were as follows:

- I. No treatment except for pathological fracture when present (22 cases).
- II. Irradiation alone (15 cases).
- III. Irradiation combined with surgery:
 1. Cases in which surgery was resorted to because of unsatisfactory results from irradiation (8 cases).
 2. Other cases in which irradiation was used, preoperatively or postoperatively (10 cases).
- IV. Surgery:
 1. Amputation (7 cases).
 2. Resection or ostectomy, sometimes combined with bone graft (11 cases).

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3. Curettage alone as primary treatment (36 cases).
4. Curettage and cauterization (21 cases).
5. Primary curettage and the use of bone chips (9 cases).
6. Secondary curettage and the use of bone chips (8 cases).
7. Primary curettage and the use of a massive graft (13 cases).
8. Secondary curettage and the use of a massive graft (3 cases).

The above groups were considered separately and results determined for each form of therapy. In recording the end results of these cases, they were graded according to the anatomical and functional results, and the roentgenographic appearance of the bone. Each of these three headings was given five possible ratings from 0 to 4. The poorest results were graded 0 and the best were graded 4.

The anatomical result included shortening, deformity, and the arrest of epiphyseal growth. The functional result was rated upon the ability of the individual to use the part, whether it was a weight-bearing bone or not; pain, limp, and limitation of joint motion were considered under this heading. The roentgenographic result depended upon the presence or absence of a cystic lesion, and its extent. The results were graded 4 when the lesions were completely healed. They were graded down if even a minute cystic lesion persisted. Recurrent lesions following treatment were graded 0. Lesions of the jaws and skull were not considered in the general grouping, because end results in these cases depend upon different criteria. They were therefore considered separately.

Cases in which there was no operation or biopsy could not, of course, be positively diagnosed, but all those included showed lesions which originally were considered to be bone cysts. Operation was not done, either because of the physician's belief that fracture would cure the lesion, or because the patient refused operative treatment.

All cases included in this study were reviewed by the writer and the results were graded uniformly by the above method.

NO TREATMENT EXCEPT FOR FRACTURE WHEN FRACTURE WAS PRESENT

There were twenty-two cases in this group, eleven of which had one or more pathological fractures. Most of these were simply treated for the fracture in the belief that cure of the lesion would follow. In no case treated in this manner was a completely satisfactory result obtained. In several cases fracture recurred later, in some many times, but even in those in which there was no recurrence at the time of follow-up examination, the roentgenogram showed a residual unhealed cavity in the presence of varying degrees of function. The results were poorer in the weight-bearing bones than they were in the non-weight-bearing bones.

Eleven patients in this group had had no fracture, but complained of pain or limp. The results are known in five of these cases and unknown in six. All of the five patients for whom the results are known had continued to have some type of pain for from three to sixteen years. The lesions as shown by the roentgenogram either remained the same or slowly

progressed in size. Gradually increasing deformity was noted in some of these patients, especially in the weight-bearing bones. In no case was healing spontaneous without treatment.

IRRADIATION ALONE

There were fifteen patients who had irradiation as the only method of treatment. The results are known in all except one case. In six cases the results were definitely poor. Apparently, there were some harmful results. Some patients sustained fractures from one to four years following treatment. In one patient, a malignant change took place, and amputation, eight years after the beginning of treatment, was followed by death from metastases. The history of this case is as follows:

CASE No. 77. The patient, a female, when first seen in 1913 at the age of 13, gave a history of a gradual onset of pain in the right leg which had started six years previously. The pain had originally begun as a sharp sudden pain with swelling in the upper tibia. After a few days the swelling had become normal and the pain had subsided. She had no further symptoms until six years later (1919). At this time she had another attack of pain in the leg accompanied by swelling. Examination revealed an enlargement of the upper third of the tibia with slight localized tenderness.

Roentgenograms revealed a localized cystic lesion, somewhat eccentric anteriorly at the junction of the upper and middle thirds of the tibia. The cortex was markedly thin and slightly perforated on the anterior aspect. No periosteal reaction was observed, and the contour of the oval-shaped cystic rarefaction was smooth and well outlined.

Radium irradiation was given on April 17 and 23, 1919.

The patient was seen from time to time and roentgenograms were interpreted as showing slight improvement. She continued to have slight pain at times and in 1922 was given further irradiation. Later mercury and iodides were given as a therapeutic test. There seemed to be slight improvement following this therapy. Further observation and roentgenograms through 1927 showed very little change in the local condition. By August 18, 1927, however, the lesion had enlarged as shown by the roentgenogram, and the pain had grown somewhat worse. She was given further irradiation at this time. The pain continued and the mass increased in size until she was admitted to the Hospital in 1928, at which time amputation at the mid-thigh was performed. She died from metastases in 1929. The pathologist's report was osteogenic sarcoma.

Although the diagnosis of localized osteitis fibrosa cystica was not confirmed by pathological sections before treatment was instituted, it seems fairly certain from a study of the available material that this was a benign bone cyst. Chondroma cannot be entirely ruled out, but it is rare in this location. That the lesion was originally a malignant one is very doubtful because of the duration of the condition before death finally intervened. This seems to be definitely an instance of malignancy which occurred in localized osteitis fibrosa cystica following irradiation.

In six other cases in this group better results were obtained, and patients who complained of pain as an original symptom were relieved of it. In no case in this entire series, however, was the result completely satisfactory from every standpoint. The patients having good function showed residual cavities in the roentgenograms. Those having a good anatomical result failed to obtain a good functional result, or also had residual cavities as shown in the roentgenograms.

PRIMARY TREATMENT BY IRRADIATION, FOLLOWED BY SURGERY

In eight cases originally treated by irradiation, the results were so unsatisfactory that operation of some type was later resorted to in an effort to improve the condition. At least a year had elapsed between irradiation therapy and operation in all but one case. This patient was operated upon one month following irradiation. In this case—a lesion of the trochanteric region of the femur—extreme decalcification followed irradiation therapy. Surgery was performed in the remaining cases from one to eight years following the original treatment.

Curettage and the use of bone chips was the procedure used in three cases. Osteotomy was done in one, resection and the massive graft in one, and simple resection in one. The results of surgery in this group of cases are known in all but one case. The only good result in this group was in the case of a lesion in the upper end of the fibula, in which resection was carried out eight years following irradiation. The results in all other cases were poor. In one patient, a malignant change developed in a lesion in the upper shaft of the humerus. The case history is as follows:

CASE No. 60, male, aged twenty-five, was first seen in 1935. At the age of nine years he had been struck on the right shoulder by another boy in an altercation. He had had some pain and soreness following this rather slight injury, which cleared up after a few days. He experienced no further discomfort whatsoever until about one year later when he fell on the ice and re-injured the right shoulder. Disability was great, and two weeks later from roentgenograms a physician made a diagnosis of bone sarcoma and advised immediate amputation. The patient's family refused this treatment. After consultation with other physicians, irradiation was instituted and he received thirteen treatments, once a month for a period of about thirteen months. Treatment was then discontinued. He had considerable stiffness in his shoulder, however, which persisted, and still another physician was consulted.

He was then taken to another hospital where at the age of eleven years, after a diagnosis of bone cyst had been made, operative treatment was carried out. Roentgenograms of the original condition are not available, but, according to all reports from various physicians, the lesion was that of a simple bone cyst. Treatment consisted of irradiation for thirteen months, and curettage in 1923.

After the operation had been performed, the patient heard the arm break and felt sudden pain. Roentgenograms, taken after this accident, revealed a fracture, and the patient was advised that the arm would never heal. He took treatments for about one year, consisting of massage and active motion, which apparently caused a pseudarthrosis at the site of the fracture. He then went along without treatment until June 1934, during which time he had no symptoms. At that time, while he was lifting some heavy furniture, he felt a sharp sudden pain in the shoulder, and was forced to discontinue his work. He continued to have pain and swelling about the shoulder and lost considerable weight.

Examination on March 18, 1935, revealed marked emaciation of the individual, with gross shortening of the right arm. There was marked atrophy in the region of the upper humerus, and this humerus was at least four inches shorter than the other one. There was considerable soft-tissue swelling, and some induration about the shoulder joint. The skin was discolored, and very tough and thickened, apparently the result of irradiation.

Roentgenograms revealed a markedly shortened humerus, with complete absence of the upper third of the humeral shaft. A space was present between the old head of the humerus and the upper end of the lower fragment. The lesion of the head of the humerus

showed marked decalcification and irregular areas of bone absorption. There was marked bone destruction.

The diagnosis, made from aspiration biopsy, was spindle-cell osteogenic sarcoma. On March 25, 1935, an interscapulothoracic amputation was performed, which was followed by treatment with Coley's toxins.

The pathological report did not state the results of a gross examination, but microscopic sections showed spindle-cell osteogenic sarcoma.

In checking up on the further details of this case, a letter from the hospital at which the original operation was performed is interesting in this connection, and is as follows:

"The patient was admitted to the Hospital January 18, 1923.

X-ray diagnosis: simple bone cyst.

Operation: excision and curettage of the cyst.

Pathology:

Gross: The curetted material from the bone lesion consists of spicules of bone, partly organized blood clot, bits of cartilage and strips of smooth white, shining membrane resembling synovial membrane. The appearance of the tissue does not suggest new growth.

Microscopic: Several pieces of curetted material differing somewhat in appearance, but representative of all the curettings, were sectioned. Some show partly organized blood clot while others show chronic inflammatory tissue. Some of it is old dense fibrous tissue and some is quite recent soft and cellular containing new capillaries and granulation tissue. There is no evidence of neoplasm."

The original sections as described above are not available for examination, but it seems quite possible that this lesion was originally a simple benign bone cyst.

IRRADIATION COMBINED WITH SURGERY

Irradiation was used as a preoperative or postoperative measure in ten cases. It was given preoperatively in only one case, and a good result followed curettage and chemical cauterization, although a very small cavity remained at the site of the lesion. Irradiation was used as a postoperative measure following simple curettage in five cases. In one of these five cases recurrence of the lesion necessitated reoperation. This time, curettage and the use of the massive graft gave a good result. No further treatment was carried out in the other four cases, but in no one of these four cases was a perfect result obtained. The results, however, were considered to be fair to good from functional and anatomical standpoints. Irradiation was used postoperatively in two cases, following curettage and the use of the massive bone graft. In one, the result was excellent, and in the other, a failure. In one patient with a poor result from simple curettage, irradiation given two years later resulted in considerable improvement. In another, with a poor result from curettage and chemical cauterization, the same operation was repeated, followed by postoperative irradiation, and a good result was obtained. It is impossible to determine the exact rôle of irradiation in these cases, because the number is too small to warrant definite conclusions. The results in this group, however, are definitely no better than in those patients in whom surgery alone of one type or another was carried out.

AMPUTATION

Amputation was performed, for different reasons, on seven patients at some time in the course of treatment. For one patient, treated in 1911, a diagnosis of chondrosarcoma had been made by the pathologist, and a hip-joint amputation was done. Later study of the material on this case revealed that it was undoubtedly a benign lesion. The patient was well eighteen years following amputation. Amputation was performed on two patients despite the pathologist's report of a benign lesion, because the surgeon believed that the condition was malignant from the clinical behavior of the lesion some time after curettage had been done. Amputation was performed on one patient because of multiple refractures and non-union. In two other cases—one in the upper end of the humerus and the other in the upper shaft of the tibia—malignant changes developed thirteen and eight years later, respectively, following irradiation therapy. One of these patients died from metastases and the other was well three years following amputation.

RESECTION OR OSTEOTOMY

Resection and replacement with a massive bone transplant, resection alone, or complete removal of the involved bone was carried out in eleven cases. Resection in cases involving the upper end of the fibula was performed in three cases with excellent results in all. Resection was performed in two cases involving the rib, with excellent results. Complete removal of the entire bone was carried out in three cases—a metatarsal, an astragalus, and a carpal navicular—with good results in each.

Resection with massive bone transplant was carried out in three cases. In two of these cases—the shaft of the radius and the shaft of the tibia—the results were excellent in every way. In one of these cases—the lower humerus—the result was not definitely known.

SIMPLE CURETTAGE ALONE

Simple curettage alone was the method of treatment in thirty-six cases. In this group no transplanted bone or chemical cauterization was used. Results in seven of these were excellent from every standpoint. Three others were excellent in every way except that the roentgenogram revealed a small residual cavity at the site of the lesion. One was excellent in every respect except that epiphyseal-growth arrest followed treatment. In four the anatomical and functional results were excellent, but no end-result roentgenograms were available for rating. Of six cases in which the results were unsatisfactory, three necessitated reoperation; one patient was later given irradiation, with improvement; and two amputations were performed because, in one, the lesion was believed to be malignant and, in the other, there were repeated fractures and non-union, with poor function. In four others the results were not good, but apparently no further treatment had been carried out. The results are unknown in nine of these and one is too recent for end-result rating.

SIMPLE CURETTAGE AND CHEMICAL CAUTERIZATION

Twenty-one cases were treated by curettage and cauterization with either zinc chloride or carbolic acid. Excellent results were obtained in six cases. In three the anatomical and functional results were excellent, but no end-result roentgenograms were available for examination. In three the anatomical and functional results were excellent, but the end-result roentgenograms revealed the presence of a small residual cavity at the site of the original lesion. In three others the results were somewhat short of excellent either because of anatomical disturbance, function, or roentgenographic appearance of the bone. The results were unknown in two, and it was too early for end-result rating in two. In two cases definite recurrence resulted and reoperation was performed at a later date.

In comparing the results from simple curettage alone and curettage combined with cauterization, it is very difficult to detect any particular advantage of one method over the other. The former group is larger, but the proportion of excellent results and recurrences is about the same for each. The amputations performed in the simple curettage group cannot necessarily be accredited to the method of treatment used.

CURETTAGE AND BONE CHIPS IN THE CAVITY AS A PRIMARY PROCEDURE

In nine of the cases, the cavity was thoroughly curetted and packed with bone chips taken from some other bone. The results were known in six, but in three it was too early to give an end-result rating.

Four of these cases were rated excellent in every respect. In two cases, the anatomical and roentgenographic results were excellent, but the functional results were graded down because of residual limitation of motion in the adjacent joint.

CURETTAGE AND BONE CHIPS IN THE CAVITY AS A SECONDARY PROCEDURE

Curettage and the use of transplanted bone chips in the cavity was used in eight cases in which some other method had already failed. Irradiation was the method originally used in four of these cases. The original method in the other four cases was as follows: curettage in one; autogenous blood injection in one; curettage and massive graft in one; and curettage and massive graft followed by irradiation in one.

The results of curettage and the use of bone chips were excellent in two cases. Poor results were obtained in two, and in one the anatomical and functional results were excellent, but the end-result roentgenogram revealed a small residual cavity. One case, originally treated by irradiation and later by bone chips in the cavity, proved to be due to a parathyroid adenoma. In two cases it was too early to determine the result. It is interesting to note in this group that the two excellent results from curettage and the use of bone chips in the cavity followed the use of either previous surgery or previous autogenous injection of blood. Most cases in which irradiation had originally been used gave poor results from surgery performed later.

CURETTAGE AND A MASSIVE GRAFT IN THE CAVITY AS A PRIMARY PROCEDURE

In thirteen cases the cavity was thoroughly curetted, and a massive bone transplant was placed in the cavity. In some cases the walls of the cavity were crushed, but in others they were not. Apparently, in no case was a combination of bone chips and a massive graft used. Eight of these cases were rated excellent in every way. One was excellent from the anatomical and functional standpoints, but the roentgenogram showed a small residual cavity. In another case the result was excellent, except that there was some residual stiffness of the joint. For one it is too early to give an end-result rating.

CURETTAGE AND THE MASSIVE GRAFT AS A SECONDARY PROCEDURE

Curettage and the use of a massive bone transplant in the cavity was used in three cases in which another method had given unsatisfactory results. Curettage was the other method in one, curettage combined with irradiation in the second, and irradiation alone in the third. The use of curettage and the massive graft gave excellent results in the cases which originally had curettage alone, or curettage combined with irradiation. A poor result was obtained in the case originally treated by irradiation.

LESIONS OF THE SKULL AND JAWS

Lesions of the skull and jaws occurred in eight cases, but the follow-up on these cases is too meager to justify any definite conclusions regarding them. These cases have therefore been excluded from any end-result calculation given in this paper, in order to prevent confusion in the end-result ratings from the various types of treatment.

SUMMARY

No excellent results were obtained in the group which had no treatment except for fracture when a fracture was present. Some of these patients improved considerably following fracture, but either deformity or a residual cavity was present as the end result in every case. No lesion in this group healed spontaneously with an excellent result.

Some patients treated by irradiation alone were definitely improved. Pain was relieved in almost all patients, when pain was present. Some patients were able to continue through life without any further treatment after the use of irradiation. In others, very little if any benefit was obtained. In a fairly large group of cases treated by irradiation, some form of surgery was resorted to later because of unsatisfactory results. There is definite evidence that surgery is less satisfactory when performed after irradiation has failed than it is when done alone. There is no evidence that preoperative or postoperative irradiation is of any benefit. Epiphyseal-growth arrest was fairly common in this group, and a malignant change took place in the bone in two cases many years after irradiation had been used. These two instances of malignant change were the only ones noted in this series.

Resection without replacement in unessential bones certainly seems to be the method of choice; this is especially true in the upper shaft of the fibula, and in the ribs. Resection and replacement with a massive bone graft, even in the essential weight-bearing bones, gave excellent results in a very small group of cases. This method of treatment may be more widely used in selected cases as surgical technique improves.

The results from simple curettage alone seem to be just as good as the results from curettage and chemical cauterization of the cavity. If cauterization is to be used, it would seem that thermal cauterization would be preferable because it can be more exactly controlled, and would not affect transplanted bone in the cavity.

In comparing the two groups of cases treated by curettage and the use of bone chips in the cavity on the one hand, and curettage with the use of a massive graft in the cavity on the other, there seems to be little choice between the two methods. The use of the massive graft in this group of cases, however, gave slightly better results than the use of multiple small chip grafts in the cavity. The combined use of the massive graft and multiple chip grafts in the cavity was not used in any case. It is possible that this method might yield better results than either of the others.

It is of interest to compare the surgical method in which no transplanted bone is used—such as simple curettage or curettage with cauterization of some form—with the method of cleaning out the cavity and transplanting either small chip grafts or the massive graft into the cavity. In the combined groups of curettage and curettage-cauterization, there are thirty-five cases, the end results of which are known. In the combined groups of bone chip and massive graft, there are twenty-eight cases in which the results are known.

Of the thirty-five cases treated by simple curettage or by curettage and cauterization, there were thirteen excellent results from every standpoint, and seven recurrences, which later required reoperation in six, and irradiation in one.

Of the twenty-eight cases in which bone chips or massive grafts were used, there were seventeen excellent results from every standpoint and only two required reoperation. The remaining results in each group were, in general, about the same.

From this study there can be no doubt that better results were obtained when transplanted bone was used in the cavity than when no bone was transplanted into the cavity.

The results of this study seem to narrow the choice of treatment in operable cases down to two methods,—that is, resection, or the use of transplanted bone after thorough cleaning out of the cavity. Irradiation should be reserved for use in inoperable cases, and should then be used only under the strictest precautions, as definite harm may result from its use.

Since most of the cases are seen in childhood, and almost all of them

are operable, it is clear that no one method of treatment could be classed as the best method to use in every case. It has been shown that poor results may follow the use of any method that has been used up to this time, except resection. In the non-essential bones, such as the shaft of the fibula and the ribs, resection is the method of choice, routinely. In growing children when the lesions are near the epiphyseal line, especially in the essential weight-bearing bones, resection is not adaptable. In these cases, thorough unroofing of the cavity, curettage, and the use of transplanted bone would seem to be the method of choice. In cases of long standing where the lesion has grown away from the epiphysis, resection and replacement by a massive bone transplant should probably be used more often.

INTERCALARY BONES OF THE INTERVERTEBRAL DISC

BY ERNST LYON, M.D., JERUSALEM, PALESTINE

The "intercalary bones" (*ossicula intercalaria*, *Schaltknochen*) of the intervertebral disc are irregularly shaped, isolated osseous formations interposed between two vertebrae, and are usually found in the anterior peripheral portion of the intervertebral disc. They occur in older individuals who suffer from spondylosis, and are found mainly in the discs of the lumbar portion, although they are occasionally encountered in the thoracic and cervical portions of the spinal column. To convey an idea of the actual appearance of these formations, the author refers the reader to the photographs of pathological preparations illustrating the articles by Niedner and Schmorl.

On roentgenographic examination, the postero-anterior view reveals irregularly outlined, smaller or larger shadows in the intervertebral space, in the neighborhood of the vertebral corner. These spots are easily identified, if they are situated between two opposite spondylotic osteophytes. The lateral view shows them as homogeneous, triangular shadows, the size of a rice kernel or even larger, situated in the anterior portion of the intervertebral space between the upper and lower edges of two adjacent bodies. They sometimes touch the edge of the vertebral body, and may approach two opposite spondylotic osteophytes; however, an open space appears between these shadows and the vertebral surface. The presence of these formations is characteristic of spondylosis.

The occurrence of spondylotic osteophytes is closely associated with changes taking place in the anterior portion of the annulus fibrosus of the intervertebral disc, the annulus of the vertebral epiphysis, the fibers of which are firmly attached to the bone tissue. The fibers are very tough and include transverse bands of so-called "tension-fibers". As a consequence of the strain imposed upon the spinal column during the course of life, a number of fissures and gaps may occur in the annulus fibrosus. The solid structure of the outer portion of the annulus fibrosus is loosened, and the connection between the annulus and the osseous epiphysis of the vertebral body is frequently disrupted. Every movement causes the anterior portion of the intervertebral disc to be pushed toward the anterior longitudinal ligament, in this way giving rise to osteophyte formation at the insertion of the ligament on the vertebral body. Schmorl believed that the injured tissue of the annulus fibrosus, or even that of the nucleus pulposus, is pushed into the fibers which are split longitudinally, and there—at a later stage—becomes subject to calcification, and is eventually converted into an "intercalary bone".

In Schmorl's posthumous paper (1932), the opinion is expressed that intercalary bones usually develop from foci of calcification, which are not infrequently encountered in the anterior portions of the annuli fibrosi of the intervertebral disc in spondylosis.

Niedner (1933) stresses the fact that the prerequisite condition for the formation of these bones—apart from fissures and gaps in the peripheral portion of the annulus fibrosus—is the presence of serious lesions, such as necrosis of these areas of the intervertebral disc. It is into these parts of the intervertebral disc, through gaps produced by tearing the epiphysis from the vertebral body, that tissue, containing vascular buds and bone-producing elements, penetrates. From this penetrating tissue, the intercalary bone develops. Spondylosis, as well as the production of intercalary bones, is possible only if the annulus fibrosus is torn away from the epiphysis of the vertebral body.

In contradistinction to a posterior herniation of the intervertebral disc—which causes bulging of the posterior longitudinal ligament, and may extend into the spinal canal—the ossicula intercalaria of the intervertebral disc may be considered as harmless spondylotic formations encountered as a rare, accessory finding in the rather frequently occurring spondylosis. This is illustrated by the following case history:

The patient, aged fifty-eight, had been suffering from recurring lumbago for some time and the pain had become more marked after he had fallen down stairs, landing on his back, three weeks before the roentgenogram was taken. The spinal column showed no evidence of pathological changes and was freely movable in any direction. Apart from spondylotic spicules, seen in the thoracic and lumbar portions of the vertebral column, the postero-anterior roentgenogram showed nothing of significance.

In the lateral view (Fig. 1), however, there are spurlike osteophytes at the anterior edges of the adjacent third, fourth, and fifth lumbar vertebral bodies. In the most anterior portion of the intervertebral space between the bodies of the fourth and fifth lumbar vertebrae, a large, homogeneous triangular shadow is visible, its density corresponding to that of the osseous tissue. This piece of bone, taking up almost the entire height of the intervertebral space, is definitely separated from the vertebral surface by intervertebral tissue. The edges of the vertebral bodies situated opposite these bone fragments are normal in appearance. Between the anterior corners of the third and fourth lumbar vertebral bodies some spots are visible, which, however, cannot be definitely identified as intercalary bones, and which may have some connection with osteophyte formation.



FIG. 1

Lateral roentgenogram of a man, aged fifty-eight, showing an intercalary bone of the intervertebral disc between the fourth and fifth lumbar vertebrae.

In this case it can easily be imagined how the intercalary bone has been produced in that part of the disc which has been pushed forward. The production of the intercalary bone must necessarily have preceded that of the osteophyte,

since the latter has adjusted itself in shape and outline to the larger intercalary bone. This is also contradictory to the assumption that the intercalary bone might have developed as a result of an accident, occurring only three weeks previously. Consequently, in this case, any claim for compensation had to be rejected.

The intercalary bone represents the ultimate stage of a curative process in a lesion, which had occurred a considerable time previously, in the outer portion of the annulus fibrosus of the intervertebral disc. It is, however, not always possible to ascertain whether these osseous formations are genuine intercalary bones or detached spondylotic osteophytes. In Figure 2 there is apparently an intercalary bone between the sixth and seventh cervical vertebrae of a woman, aged fifty-nine. However, it is also possible that, in the manner described previously, an osteophyte may have developed into an intercalary bone. Both formations, in any event, are of spondylotic nature.

DIFFERENTIAL DIAGNOSIS

Very rarely calcification and ossification of the nucleus pulposus of the intervertebral disc are also encountered in connection with spondylosis. In these cases, the fissures in the fibrous structure of the annulus fibrosus have extended up to the wall of the nuclear cavity, and thus permit a part of the nucleus material to escape. This severely interferes with the function of the nucleus pulposus and the entire intervertebral disc. The nucleus pulposus may become subject to calcification; it may also show vascularization originating from the gaps in the vertebral epiphysis; and it may eventually become ossified. This process of calcification and ossification of the nucleus pulposus is similar in nature to the formation of intercalary bones in the anterior part of the intervertebral disc.

In a woman of fifty-nine, who suffered from severe back pain from time to time, the spinal column showed no changes in its outward appearance, although there was some limitation of movement in all directions. In the intervertebral space between the seventh and eighth thoracic vertebrae, as shown in the roentgenogram (Fig. 3-A), there are, particularly in the area of the nucleus pulposus, a number of intense linear



FIG. 2

Lateral roentgenogram of a woman, aged fifty-nine, showing an intercalary bone between the sixth and seventh cervical vertebrae (arrow), and calcification of the anterior longitudinal ligament (O).

shadows. From the region of the lower right edge of the seventh thoracic vertebra, an osteophyte runs in a curved line in an outward-downward direction, touching upon an osteophyte of the upper outline of the eighth thoracic vertebra. Intermingled with this are seen several fine bands of calcific shadows.

In the lateral view (Fig. 3-B), the roentgenogram reveals the calcific shadows in the center of the intervertebral space to be horizontal bands. In this view the thickening of the anterior edges of the seventh and eighth thoracic vertebrae is also evident. The other vertebrae, too, show small osteophytes at their anterior edges. The calcification and ossification of the nucleus pulposus, seen in the postero-anterior view, appears in the lateral one as a central shadow in the intervertebral space. The roentgenographic appearance changes in accordance with the varying shape of the nucleus pulposus and, moreover, in accordance with the direction from which the roentgenogram is taken. The spots of calcification and ossification are seen as cloudy, patchy shadows,—sometimes arranged like the skin of an onion, depending upon the presence of lime depositions

in the fissures and villi of the cavity within the nucleus pulposus which von Luschka first described, and sometimes filling the entire cavity. Clinical differentiation between calcification and ossification, as indicated by Schmorl, is not always possible from

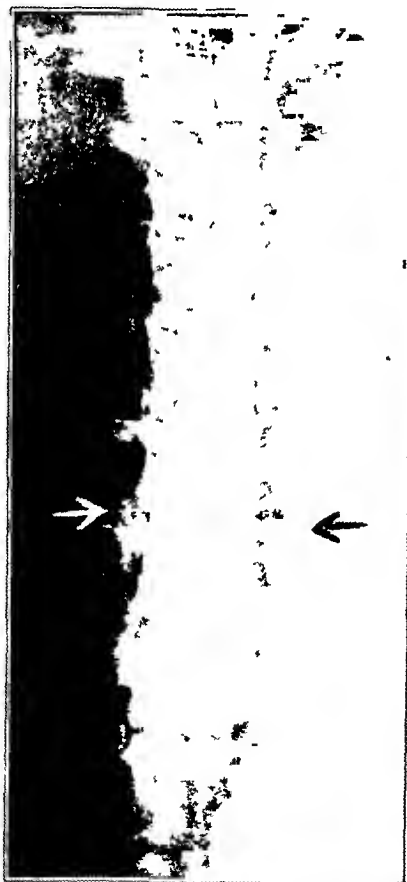


FIG. 3-A



FIG. 3-B

Postero-anterior and lateral roentgenograms of a woman, aged fifty-nine, showing calcification and ossification of the nucleus pulposus of the intervertebral disc between the seventh and eighth thoracic vertebrae.

the roentgenographic appearance. The intercalary bone, however, either does not appear at all in the postero-anterior view (where it may be overshadowed by osteophytes), or represents an isolated central patch of ossification between two lateral osteophytes. In the lateral view, the intercalary bone appears between the thickened portions of the opposite edges of two vertebral bodies as an isolated triangular shadow in the intervertebral space, with the same degree of density as is found in the spongiosa of the vertebral body.

Intercalary bones, as well as calcification and ossification of the nucleus pulposus in the intervertebral disc in spondylosis, have nothing in common with the calcified foci in the nucleus pulposus, which are met with in juveniles as a sequel to infectious diseases. Since the vertebral disc remains vascularized up to the age of twenty-five years, calcification, as a consequence of metastatic infection of the intervertebral disc, may be possible up to that age; but in the higher-age groups degenerative changes, such as calcification of the nucleus pulposus, have to be considered.

Metastatic inflammation as the exciting factor in the production of calcification in the center of the intervertebral disc between the sixth and seventh thoracic vertebrae was found in a boy, eight years of age (Figs. 4-A and 4-B). He had had a temperature for two days, following which he could not freely move his head and right arm. He had had pain in the right arm and in the neck, which had disappeared after a fortnight. In the lateral view (Fig. 4-A) taken on November 23, 1931, a shadow, the size of a bean, is seen in the area of the nucleus pulposus between the sixth and seventh cervical vertebrae. In the postero-anterior roentgenogram taken on April 4, 1932 (Fig. 4-B), there is still another shadow in the mid-line and two smaller ones in its neighborhood. After eight months the calcified patches of the intervertebral disc had completely disappeared.

Disappearance of the calcified foci in the area of the nucleus pulposus of the intervertebral disc is a feature characteristic of the metastatic type developing in early childhood. However, retrogressive changes of the type of degenerative calcification usually encountered in older persons, are extraordinarily rare, and ossification of the nucleus pulposus or intercalary bones has never been observed.

A triangular shadow which may appear at the anterior upper edge of one of the lumbar vertebrae, produced by the intrusion of the tissue of the intervertebral disc into the spongiosa of the vertebral body, provides scarcely any difficulty in the differential diagnosis. In the outermost portion of the annulus fibrosus, calcium shadows are not infrequently found, which are impossible to distinguish from intercalary bones; only when the calcification of the annulus fibrosus has reached a certain proportion can it be revealed by roentgenograms in the living organism. In the lateral view, the calcium shadows appear as lines or small dots in the intervertebral spaces. Güntz is certainly wrong in believing that in the presence of spondylosis the formation of intercalary bones is more prob-

able than is the simple deposition of calcium in the area of the annulus fibrosus. In certain individuals extraordinary tension and strain imposed on the anterior portion of the intervertebral disc stimulate the deposition of calcium salts there, and this is particularly so in the case of spondylosis.



Fig. 4-A

This is also in accordance with Schmorl's view that intercalary bones develop from foci of calcification in the pathologically changed anterior portion of the annulus fibrosus in spondylosis.



Fig. 4-B

Fig. 4-A: November 23, 1931. Lateral roentgenogram of a boy, aged eight, showing calcification of the nucleus pulposus of the intervertebral disc between the sixth and seventh cervical vertebrae.

Fig. 4-B: April 14, 1932. Anteroposterior view.

By exposure to increased tension, small foci of calcification or ossification may also develop in the anterior longitudinal ligament (Fig. 2, *o*), and may produce lateral roentgenographic appearances very similar to those of intercalary bones. However, considerable calcification of the anterior longitudinal ligament in the lumbar portion of the spinal column may produce arches which sometimes extend to a considerable height at the vertebral body; roentgenograms of this type are not easily mistaken for intercalary bones. An osteophyte, characteristic of spondylosis, may be partly or completely detached from the tissue of the intervertebral disc which has penetrated it, and may even break off. If such an osteophyte happens to protrude far in an outward direction, it may produce a roentgenographic appearance similar to that of an intercalary bone.

SUMMARY

1. The intercalary bone of the intervertebral disc is an osseous formation completely surrounded by the tissue of the intervertebral disc,—that is, it is interposed between the two intervertebral bodies.

2. Considering the high incidence of spondylosis, these formations provide a rare accidental finding of only secondary importance.

3. Symptoms, if any are present, are not characteristic of the condition; particular symptoms definitely connected with the presence of intercalary bones do not exist. The intercalary bones do not occur as a sequel to an accident. Intercalary bones, as well as calcification and ossification of the nucleus pulposus, are encountered in connection with spondylosis, providing that a certain degree of wear and tear of the intervertebral disc has occurred. They represent the ultimate stage of a curative process in a lesion of the outer portion of the intervertebral disc and of the nucleus pulposus, which had occurred a considerable time before.

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AN ARTHROPLASTY FOR CONGENITAL DISLOCATION OF THE HIP *

A LATE FOLLOW-UP REPORT

BY PAUL C. COLONNA, M.D., PHILADELPHIA, PENNSYLVANIA

In June of 1929 at Bellevue Hospital, New York City, a boy of seven with bilateral, congenital dislocation of the hip was treated by the author. An open operation was performed without any preliminary traction. With a great deal of effort, the right hip was reduced, and, although the head was finally placed in the old acetabulum "by main strength and awkwardness", a marked limitation of motion developed, and subsequent roentgenograms showed fragmentation of the head and a severe grade of traumatic arthritis. This unsatisfactory result of an open reduction at this age impressed the author strongly. The result was attributed to several factors,—among them the necessity for a preliminary stretching of the soft tissues, the danger of an excessive degree of trauma at the time of the reduction, and the fact that a deficient acetabulum always makes reduction difficult and retention hazardous. Therefore, before attempting to reduce the opposite hip the next year, this child received a long period of preliminary traction. In June of 1930 an open operation was performed on the left hip using, for the first time, the procedure to be reported.

OBSERVATIONS ON THE PATHOLOGICAL PICTURE

In all congenital dislocations of the hip, the roentgenograms are, of course, of great aid in evaluating the malformations which may be present in the head and acetabulum, particularly the shallowness of the latter; and these factors are recognized as being of prime importance in the permanency of any reduction. However, because attention has so often been centered upon the bony elements in this deformity, the important rôle which the soft tissues play in preventing true reduction has not always been visualized. Of these structures, the capsule occupies a rôle of the utmost importance. Under the stresses and strains of weight-bearing, the head, in the great majority of cases, assumes an upward and posterior position in relation to the poorly formed acetabulum, and, as the head travels upward and backward, the hour-glass type of capsule develops. This means that the isthmuslike portion of the attenuated capsule may be of varying length and diameter, depending upon the location of the capsule-covered head, because the change in shape of the capsule in the dislocated hip will be dependent upon the stresses and strains of weight-bearing. Therefore, the capsule will be found to be thickened over the

* Read at the New York Academy of Medicine before the Section on Orthopaedic Surgery, April 17, 1942.

superior cartilage of the head where a great portion of the weight is borne.

Also the pelvitrochanteric group of muscles, as well as the larger blood vessels and nerves, all become contracted because of the backward and upward displacement of the head, and, because of this shortening, render reduction difficult. Therefore, a preliminary stretching is usually necessary before reduction should be attempted. Whenever the head is posterior to the sagittal plane of the pelvis, lordosis is bound to be a constantly deforming element; and, until this backward and upward displacement is corrected, both the lurch and the lordosis will persist. This the arthroplasty operation attempts to do. This two-stage procedure was first described in *The Journal of Bone and Joint Surgery* in April, 1932.

INDICATIONS FOR THE PROCEDURE

The procedure advocated has been found most useful in two types of cases; first, in patients under three years of age whose hips have been satisfactorily reduced by closed manipulation, but, in spite of careful care, have not remained reduced. The percentage of failures following closed manipulation will vary widely, depending upon the clinic reporting any large number of follow-up cases. A conservative estimate of redislocations within this age group would probably be somewhere around 25 per cent. The second group of cases includes patients over three years of age and under ten. It is felt that open operation is the method of choice in any case of congenital dislocation in a child between three and five years of age, but that in a patient over five years of age, closed reduction should not be attempted.

The age of the patient is the factor largely determining the type of procedure to be employed in treating congenital dislocation of the hip. In children *over* ten with unilateral dislocations, and *over* seven with bilateral, a reconstruction of the acetabulum as described by Gill is preferred. At times, however, it is believed that an arthrodesis, as recommended recently by Frankel, may be advisable in certain unilateral cases. The arthroplasty advocated has been performed on a few patients who were about twelve years of age, and, although stability has been obtained, there has been an aseptic necrosis of the head with increased stiffness of the hip. It is, therefore, felt that there is a definite age limitation to the operation described in this paper.

THE PROCEDURE ADVOCATED

First Stage

Twenty-four hours before any preliminary stretching is done, moleskin adhesive straps are applied to the affected limb. These straps extend to within a few inches of the tip of the greater trochanter laterally and to the groin medially. The following day, after the moleskin has attached itself to the skin, the dislocated hip is thoroughly stretched under anaesthesia, and the adductor muscles are subcutaneously tenotomized. No attempt is made to reduce the dislocation at this time. A long, plaster

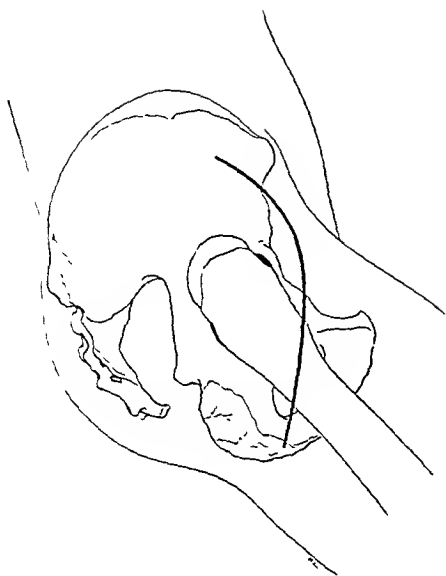


FIG. 1-A

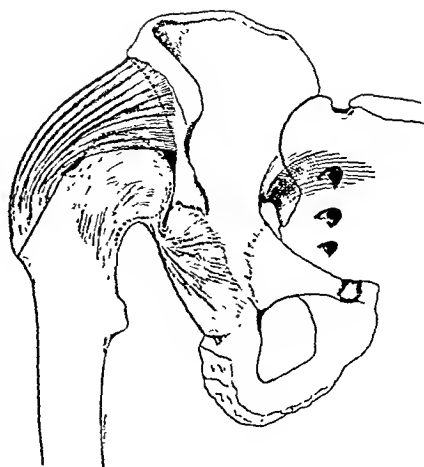


FIG 1-B

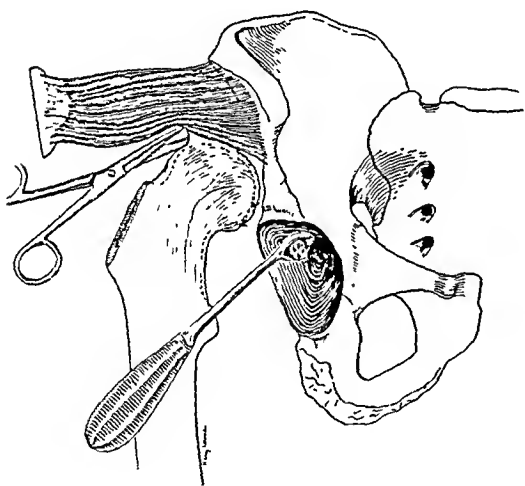


FIG. 1-C



FIG. 1-D

Fig. 1-A: Skin incision.

Fig. 1-B: Diagrammatic view of the hour-glass appearance of the capsule. Drawing shows how the greater trochanter is chiseled through.

Fig. 1-C: The greater trochanter with its attached muscles is retracted upward and the capsule is easily separated from the surrounding structures and followed down to its isthmus. The capsule is then cut across, and by several sutures is made into a sac covering the head. With a Doyen reamer or large curette, a smooth, capacious acetabulum is made at the site of the original acetabulum.

Fig. 1-D: The head with its synovial-lined capsule is then placed deep in the newly formed acetabulum; the greater trochanter is replaced and held with several kangaroo sutures; and the wound is closed in layers. A long plaster spica is then applied with the limb in 15 to 20 degrees of abduction. (*Reproduced by courtesy of Surgery, Gynecology and Obstetrics.*)

spica is then applied to the opposite side, and ten to fifteen pounds of skin traction is immediately applied to the dislocated side. In some instances skeletal traction has been used. The weight is increased gradually over a

period of two or three weeks, and roentgenograms are taken with and without traction to determine the actual stretching of the soft tissues. This preliminary traction period, which is the first stage, may require several or more weeks. Until the soft structures about the hip have been mobilized sufficiently to bring the head down approximately opposite the level of the old acetabulum, the second stage (open operation) of the procedure *should not be attempted*, and this position can be accurately determined only by roentgenogram. Individual cases may vary considerably in the degree of telescoping possible and in the amount of relaxation that can be obtained by preliminary traction. Therefore, in some of the very young patients with marked relaxation it has not been found necessary to employ preliminary traction. When the maximum amount of stretching has been obtained, the plaster spica is bivalved, and the hip region is prepared in the usual manner, disturbing as little as necessary the moleskin straps. The patient is sent to the operating room with the traction intact.

Second Stage

A skin incision is made, beginning about two inches behind the anterior superior spine, and curving downward and then backward, to a point about two inches below the tip of the greater trochanter. The fascia is then divided by a curved incision paralleling the skin incision. The rectus femoris tendon at its origin on the anterior inferior spine is identified and is divided, sometimes by zig-zag tenotomy. The greater trochanter, with its attached muscles, is chisled through, and is turned upward, and the capsule is easily separated from the surrounding structures by scissors dissection. When the isthmus of the capsule is reached, it is divided, and the head of the bone is inspected, as to its shape and appearance, and the presence or absence of the ligamentum teres. Any remodeling of the head is to be strongly condemned, for there is evidence to believe that the contour of the head will have a tendency to approach its normal shape if the cartilage is left intact. The opening in the capsule is then closed with several chromic sutures. With reamers or curette, a capacious acetabulum is formed as near its original site as preliminary traction has made possible. No skid or unusual force should ever be necessary to reduce the head into the reamed-out acetabulum if the preliminary period of traction has been adequate, for the capsule-covered head must be placed gently into the deepened and reamed-out acetabulum to give the best opportunity for free movement later. The greater trochanter is then sutured back into place, and the wound is closed in layers. A long plaster spica, incorporating the traction straps in the plaster, is then applied while the limb is held in about 20 degrees of abduction and complete extension.

POSTOPERATIVE CARE

The convalescent care in these cases is a very important step in preserving stability and mobility. The original plaster spica is worn for four

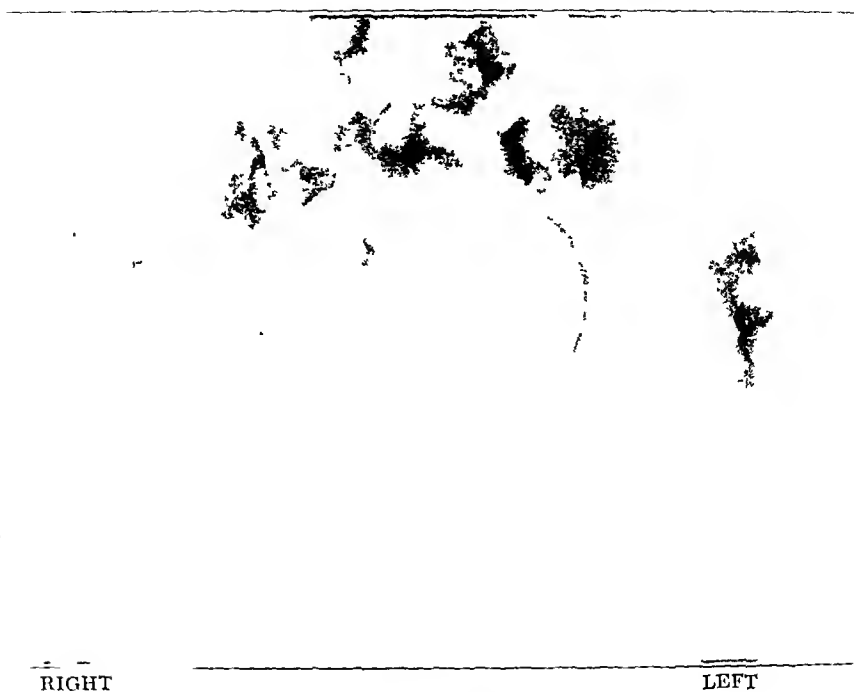


FIG. 2-A
Case 1. P. S. On admission.



FIG. 2-B

May 3, 1930. Before operation on the left hip. The right hip had been reduced without any preliminary traction and without the preservation of the capsule over the head of the bone. At present the right hip is stiff.



FIG. 2-C

May 21, 1935. Five years after operation on the left hip. The arthroplasty operation was done only on the left side, and there is at present stability and a good range of mobility.

weeks after operation, although two weeks after operation the posterior portion covering the foot and leg is removed at intervals during the day, and the patient actively moves the foot and knee. Four weeks after the operative stage the plaster spica is completely removed; and a posterior shell, extending from the groin to the toes, is prepared; so that, by means of an overhead suspension bar, active and passive movement at the hip can be begun. Care is taken to keep the limb slightly abducted at all times, and this is most easily accomplished by placing a small pillow between the legs. If a therapeutic pool is available, it is an advantage to have the patient begin under-water exercises at about this time.

During the convalescent period, the hip must be carefully watched for evidences of adductor muscle spasm; and, if this develops, no attempt should be made to force motion for a few weeks. Traction and rest to the limb will usually suffice to overcome this tendency, and active motion can be started again.

It must be remembered that a considerable degree of accommodative change must take place within the first few months following a procedure of this sort. After the capsule has been reduced into the reconstructed acetabulum, a firm union between the capsule and the bony walls of the new

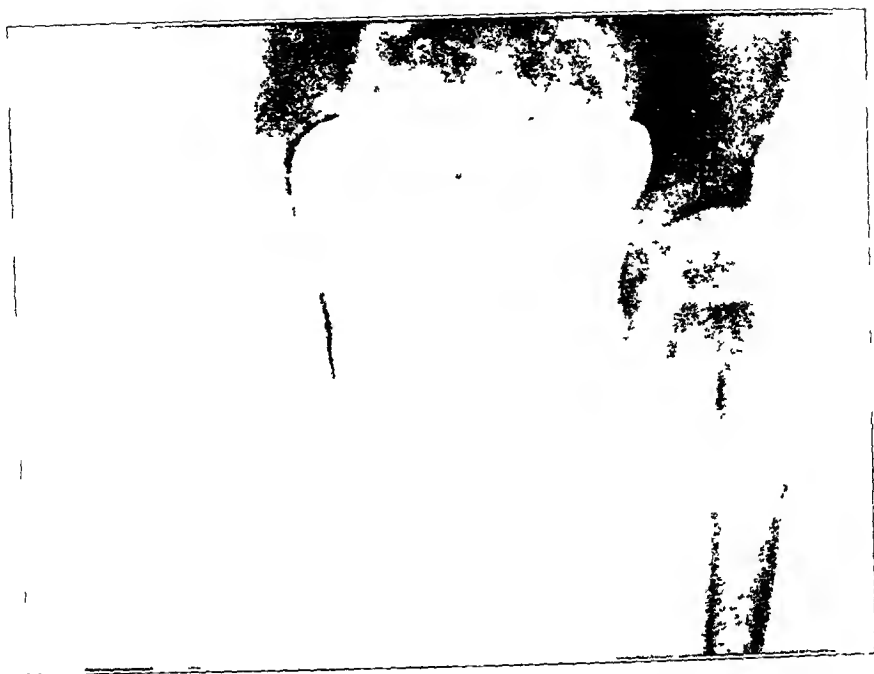


FIG. 3-A

Case 2 B. A. September 5, 1935. Before operation on the right hip.



FIG. 3-B

January 17, 1942. More than six years after the arthroplasty, the patient presents a practically normal range of movement.

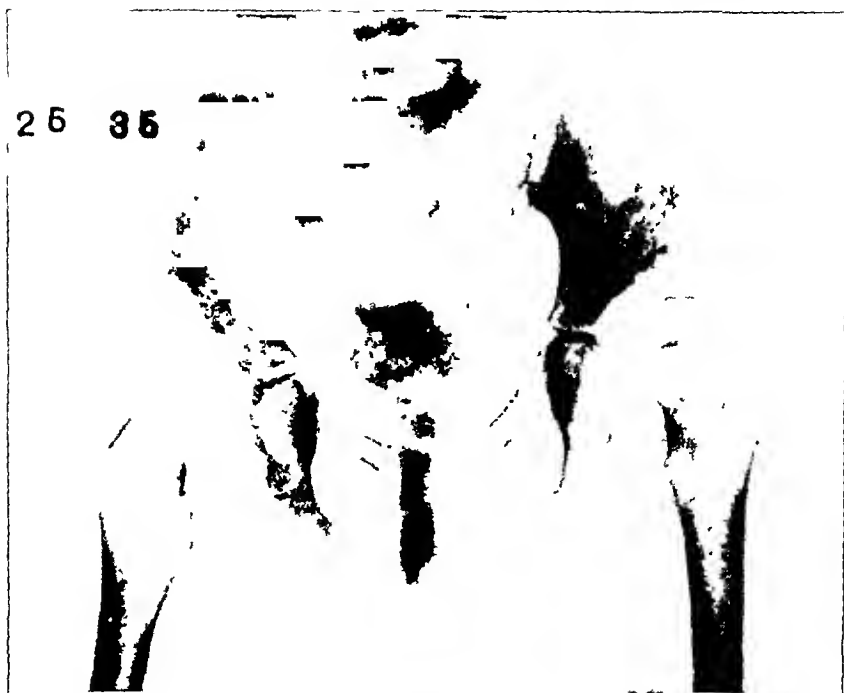


FIG. 4-A

Case 3 D. R. January 25, 1935. Before operation on the right hip.

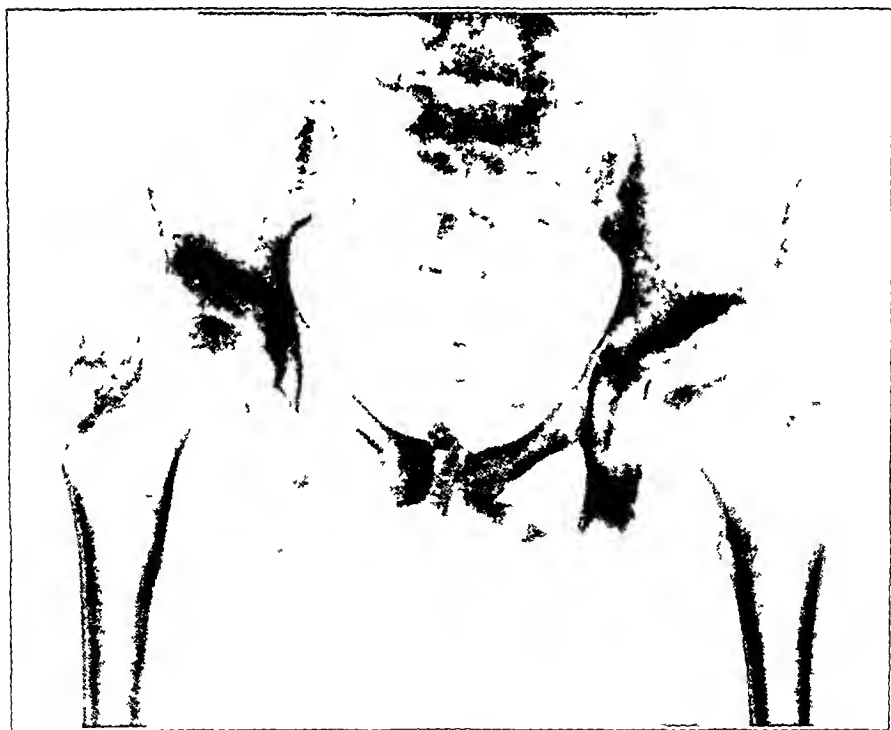


FIG. 4-B

January 17, 1942. Seven years after operation. The patient has a stable hip, an excellent range of motion in all directions, and no shortening. She walks without a limp.



FIG. 5-A

Case 4. D K. September 26, 1933. Before operation on the left hip.



FIG. 5-B

January 17, 1942. Eight years after operation. The patient has a stable hip with an excellent range of motion and walks without a limp. Note the normal joint space and the restoration of the normal contour to the head of the femur.

acetabulum must develop, and from roentgenograms of patients taken many years after operation, it must be assumed that the lining of this reconstructed acetabulum closely resembles the normal articular cartilage.

No weight-bearing is allowed for at least three months after the second-stage procedure, and in some instances it has been found useful to fit the patient with a Thomas ring knee splint and to elevate the opposite shoe in order to relieve the hip from full weight-bearing for a few months longer.

END RESULTS

In selected cases, the method described is felt to offer an opportunity for accomplishing several objectives. First, it corrects the backward and upward displacement of the head and, therefore, the lordosis and lurch of the body on weight-bearing. The operation also lessens, or completely overcomes, the shortening of the affected extremity; and it secures stability and mobility to the congenitally dislocated and unstable hip.

The author has wanted to know for some time what ultimately happens to these hips. The first patient was treated by this procedure in 1930, but was lost track of after a five-year follow-up. When the patient was last seen the result could be classed as quite satisfactory both functionally and roentgenographically (Fig. 2-C).

Five other patients who were operated upon a few years after this first patient can now be reviewed. In two, the follow-up has been over nine years; in two, over seven; and in one, about six and one-half years. In 1936, when these five cases were reported, it was stated, "the time of follow-up with the procedure advocated is insufficient to draw any definite conclusions as to what will be the ultimate functional and roentgenographic appearance of these hips". It can now be said that the functional results in these five patients are quite satisfactory. They walk today with hardly a limp, and present an excellent range of motion in all directions.

From the roentgenographic standpoint, a review of these cases has been particularly interesting, and the following facts can be demonstrated from the recent roentgenograms:

1. The depth of the reamed-out acetabulum has remained unchanged or, in some cases, has become apparently deepened after years of weight-bearing.
2. An increased density of the roof of the acetabulum has been a frequent observation in this follow-up study.
3. It may be noted that the time of fusion of the acetabular floor has been hastened.
4. Aseptic necrosis has not developed in the head of the femur in any of these cases. This is particularly interesting when it is remembered that the ligamentum teres, when present, is removed in all cases, to allow

the capsule to be sutured as a sac over the femoral head during the second stage of the operation.



FIG. 6-A

Case 5. P. Z. December 2, 1932. Before operation on the right hip and at the end of the first stage, showing that the head has been pulled down opposite the old acetabulum. This is a prerequisite to open operation.

5. There has been no diminution of the joint space postoperatively, when the patient has been operated upon within the age limits previously defined.

6. The roentgenographic development of the upper femoral epiphyses has been uniform, and, in some instances, a normal contour has developed following operation in an epiphysis preoperatively deformed.

7. There have been no redislocations, and the stability of the hip has been assured.

8. There has been very little, if any, posttraumatic arthritis noted in any of these patients, two of whom were operated upon more than nine years ago.



FIG. 6-B

April 15, 1936.

CASE REPORTS

CASE 1. P. S., a boy, seven years of age, was admitted to the Orthopaedic Service at Bellevue Hospital, New York City, in June 1929. He presented the characteristic features of congenital dislocation of both hips (Fig. 2-A).

On December 19, 1929, the right hip was operated upon without preliminary traction, and the dislocation was reduced with difficulty. The head was forced into a reamed-out acetabulum with a skid. The result proved unsatisfactory, and the hip has become increasingly stiff. As shown in the roentgenograms, the bony proliferation about the joint has increased since the operation.

On June 1, 1930, the procedure here advocated was performed on the left hip. The structures were stretched, the adductors were tenotomized, and heavy skin traction was applied, as described in the first stage of the treatment. On June 16, 1930, the second stage was completed.

In roentgenograms taken five years after operation on the left hip (Fig. 2-C) a definite joint space appears to have developed. This joint presented about 80 degrees of voluntary flexion from complete extension. The Trendelenburg sign is negative on the left side.

CASE 2. B. A., a girl of three years and ten months, was admitted to the Hospital for the Ruptured and Crippled (now the Hospital for Special Surgery) in October, 1935. This child had previously had two unsuccessful attempts at closed reduction of the right hip. She had a shallow acetabulum and deficient roof, so that further attempts at closed reduction were not thought advisable. On admission the child was in good general condition, but had the characteristic limp on walking, and a positive Trendelenburg sign.

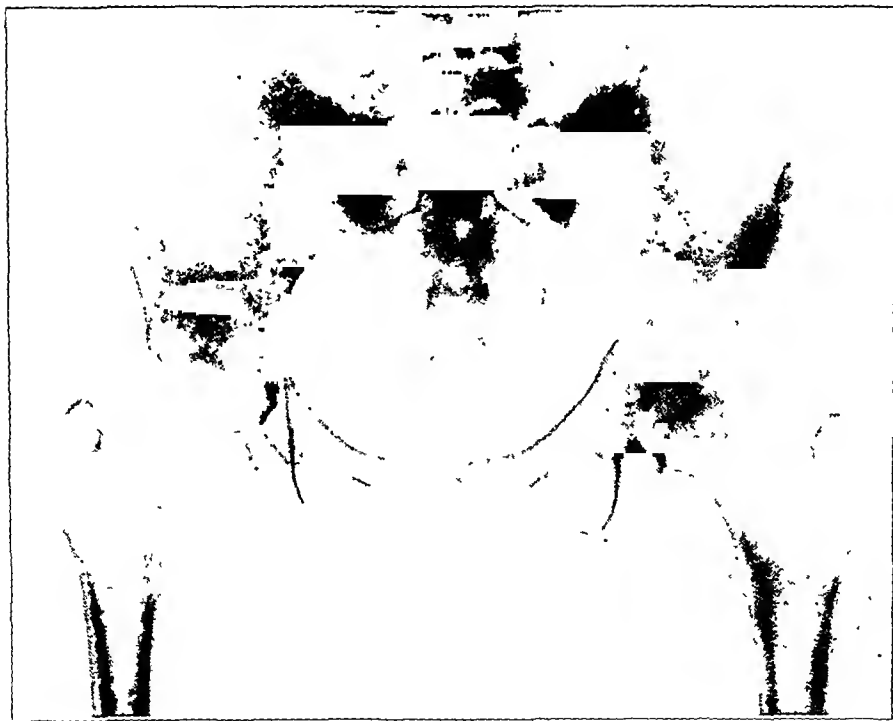


FIG. 6-C

January 17, 1942. Nine years after open operation. The hip is stable and presents a normal range of motion. The epiphysis is well developed and there is no perceptible limp.

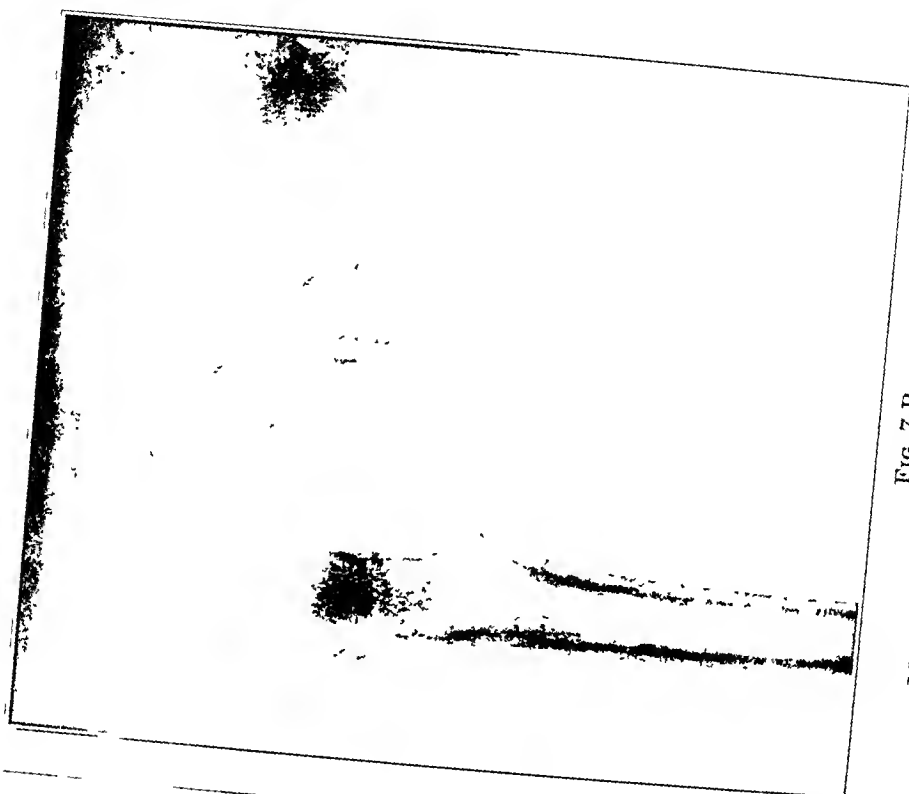


FIG. 7-B
May 2, 1933. At the end of the first stage.

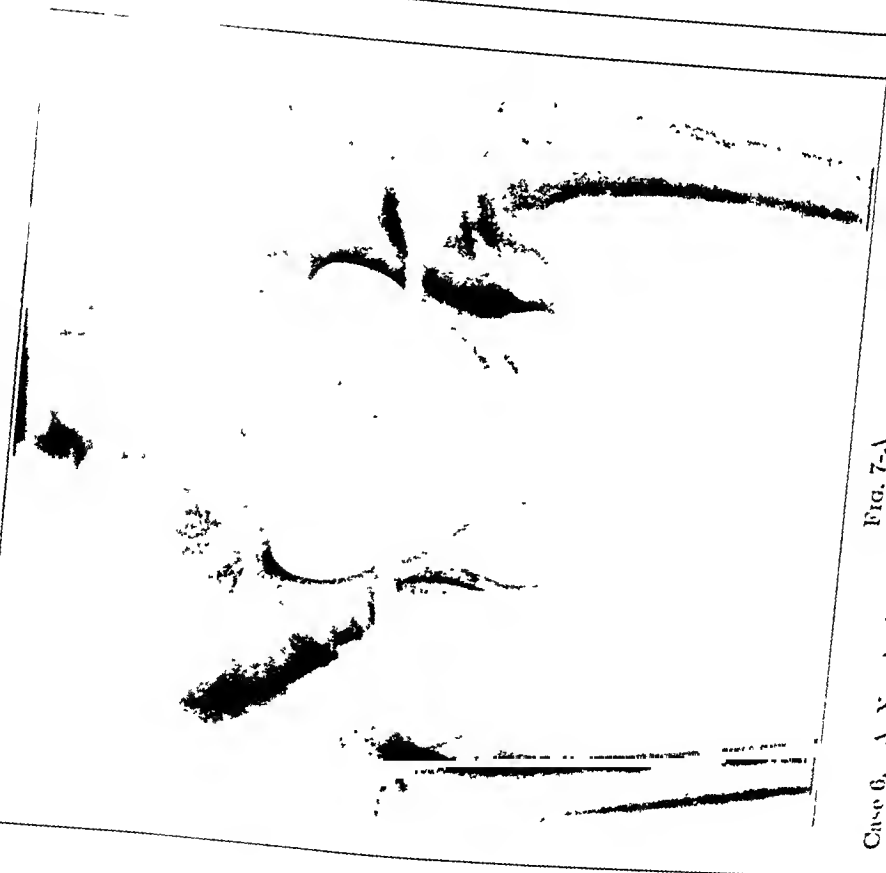


FIG. 7-A
Case 6. A. Y. April 21, 1933. - Before operation on the right hip.



FIG. 7-C

January 17, 1942. Nine years after operation. Patient presents no shortening, has a complete range of movement, and walks without a limp. Roentgenogram shows normal development of the head and normal joint space.

On October 1, 1935, the first stage of treatment was begun, and on October 25, 1935, the second stage.

At present she walks with only a slight limp. The Trendelenburg sign is negative and she has a normal range of motion. Roentgenogram (Fig. 3-B) shows the appearance of the hip six and one-half years after operation.

CASE 3. D. R., a girl of three, was seen at the Hospital for the Ruptured and Crippled in January 1935. This patient originally had been under treatment at this Hospital for bilateral congenital dislocation. Six months previously the right congenital dislocation had been reduced by closed manipulation, but had redislocated (Fig. 4-A).

The child presented a rather insecure left hip and a frankly dislocated right hip. There was the characteristic limp on the right, and a shortening of one-half inch. Open operation was advised.

No preliminary traction was necessary in this case, and on February 13, 1935, the operation on the right hip was performed.

At present the child has no shortening, and the Trendelenburg sign is negative on both sides. She is very active and has a good range of movement of the right hip in all directions (Fig. 4-B).

CASE 4. D. K., a girl of four and one-half years, was admitted to the Hospital for the Ruptured and Crippled in December 1933, with a congenital dislocation of the left hip. She had had three previous attempts at closed reduction, and each time the dislocation had recurred on removal of the plaster (Fig. 5-A).

On admission the child was in good general condition, but had a marked limp and a positive Trendelenburg sign. There was one-half inch of shortening.

On January 3, 1934, the first stage of treatment was begun and on January 15, 1934, the second stage.

At present the child walks with a limp, but there is no shortening and she has a normal range of motion (Fig. 5-B). The Trendelenburg sign is negative.

CASE 5. P. Z., a girl of four and one-half years, was admitted to the Hospital for the Ruptured and Crippled in November 1932, with a congenital dislocation of the right hip. This patient had never had any previous treatment for the dislocation, and presented the characteristic findings of a unilateral dislocation. There was one-half inch of shortening and a positive Trendelenburg sign.

On November 21, 1932, the first stage of treatment was begun, and on December 5, 1932, the second stage. Figure 6-A shows the condition at the end of the first stage of treatment, and Figure 6-B over three years after operation.

At present the child walks without a limp. The Trendelenburg sign is negative and she has a normal range of movement. Attention is called to the width of the joint space, and the size and apparent smoothness of the outline of the epiphysis years after the operation. Roentgenogram (Fig. 6-C) shows the appearance of the hip nine years after the operation.

CASE 6. A. Y., a girl of six, was admitted to the Orthopaedic Service of Bellevue Hospital in April 1933, with a congenital dislocation of the right hip (Fig. 7-A). When the child was an infant several attempts had been made to reduce the dislocation, but none had been successful. On admission she was in good general condition, but had the gait characteristic of a dislocation of the right hip. The Trendelenburg sign was positive, and there was shortening of three-quarters of an inch.

On April 20, 1933, the first stage of treatment was begun, and on May 5, 1933, the second stage. Figure 7-B shows the condition at the end of the first stage of treatment.

At present the child walks without a perceptible limp. There is no shortening and she has an almost normal range of movement in all directions. The Trendelenburg sign is negative. Roentgenogram (Fig. 7-C) shows the appearance of the hip nine years after the operation.

The above cases were reported by the author in an article published in *Surgery, Gynecology and Obstetrics* (LXIII, 777, 1936), with the results at that time. Material and illustrations from that article are reproduced by courtesy of *Surgery, Gynecology and Obstetrics*.

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muscle spasm, and it allows rapid correction of deformities and more vigorous attempts at restoration of muscle balance.

In combining the roentgen and orthopaedic therapies, the following regimen is carried out: On admission, a complete physical examination is

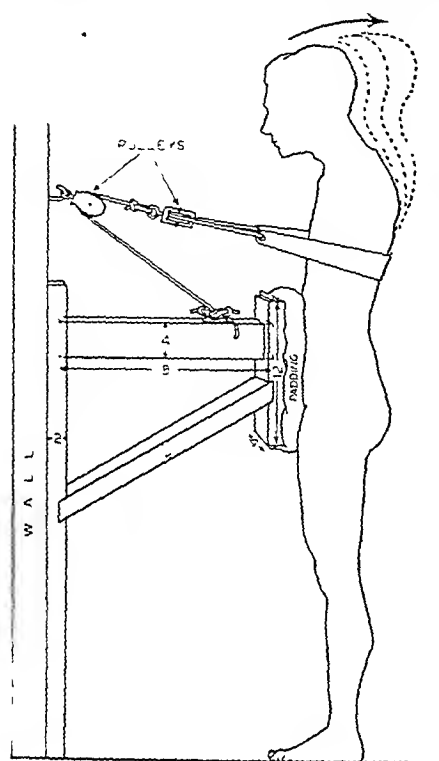


FIG. 2

made, measurements of height and measurements of chest and chest expansion are recorded, and photographs and roentgenograms are secured. A thorough search is made for foci of infection, which, if found, are removed. Complete blood studies, which include routine cell and hemoglobin determinations as well as sedimentation rate and Weldman reactions, are carried out. Roentgenotherapy, if not contra-indicated, is given over either the entire spine or the involved area, depending on the clinical findings. Two hundred kilovolts is used in treating areas of about five by fifteen centimeters. One hundred and fifty roentgen units are given over one or more areas daily for three to five treatments; if necessary, the dosage is repeated after three to six weeks.

When needed, blood transfusions are given to build up the patient's general condition and to counteract any

effects which the roentgenotherapy may have on the hemopoietic system. If nausea develops during the treatment, intravenous fluids are used, the dosage of the roentgen ray is reduced, and the exposures are spaced farther apart. As soon as the patient has experienced alleviation of pain, attempts at correction of the deformities are started.

The patient is placed on a bed equipped with a sponge rubber or latex mattress with a fracture board. The fracture board is so hinged as to conform to a Gatch bed, and correction is obtained by placing the patient's head toward the foot of the bed as shown in Figure 1. If such a mattress is not available, a Bradford frame is used for this purpose. The patient is given physiotherapy daily,—heat and massage to the abdomen and back, and instructions in corrective exercises. In carrying out exercises in the early cases, it was found that the greatest effect of the forces was gained in the lumbar area, and that little was accomplished in correcting the dorsal curve and in developing the upper sacrospinalis. To overcome this difficulty, the apparatus as demonstrated in Figure 2 was designed. As a means of preventing hyperextension at the lumbosacral junction while using the apparatus, the patient fixes his pelvis with his gluteal and abdominal muscles, and the body strap is put on sufficiently tight to act as a fulcrum and to allow the greatest portion of the hyperextend-

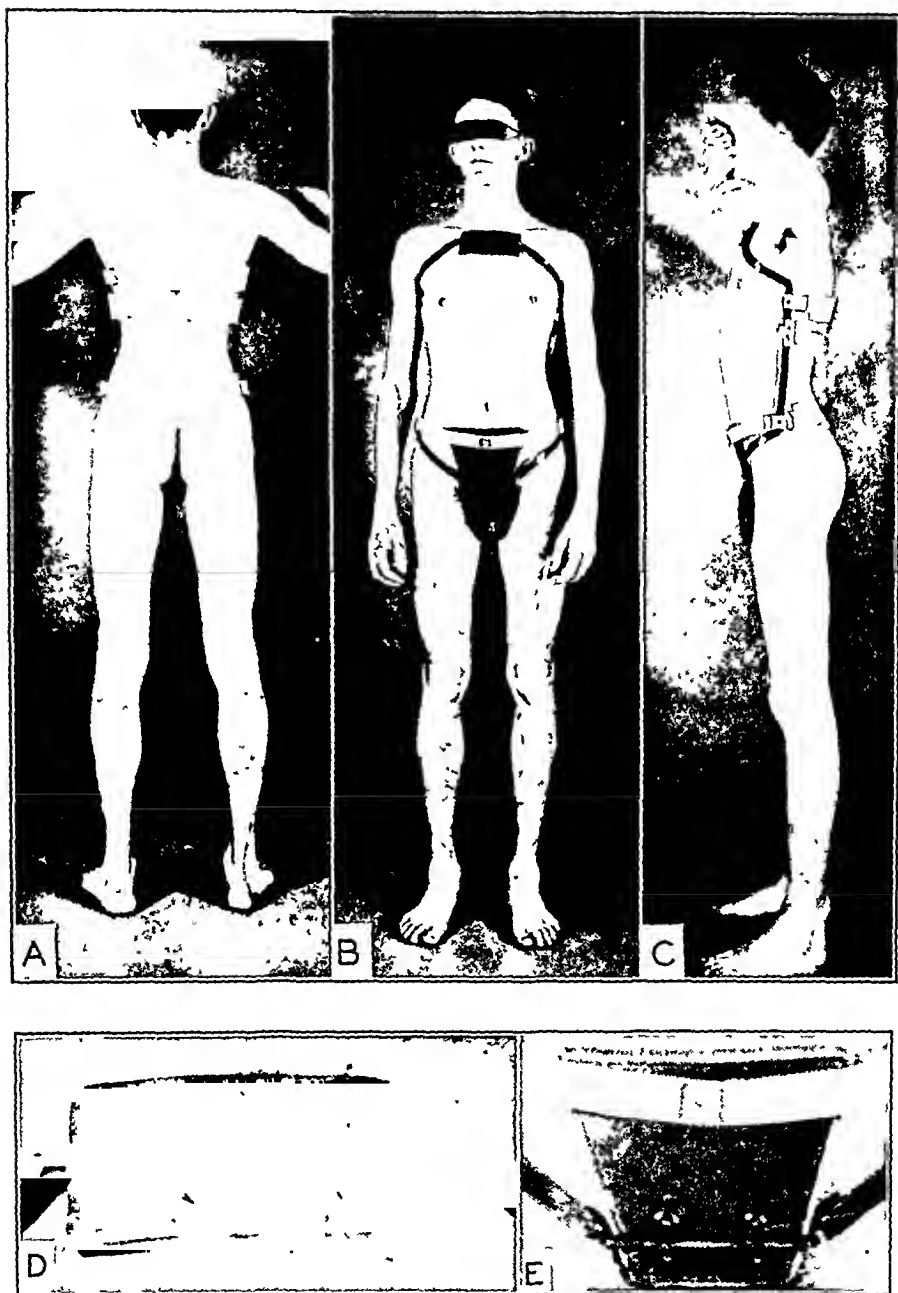


FIG. 3

ing forces to take effect in the region where the strap or belt is fitted.

In warm climates the casts and leather jackets as described by Swaim are uncomfortable; so it was necessary to develop a brace which would maintain and, if possible, give further correction; which would control rotation, and at the same time be comfortable both as to fit and as to body-surface temperature. In trying to meet these requirements the brace illustrated in Figure 3 was designed. It is made of orthopaedic steel five-eighths of

an inch wide and one-eighth of an inch thick. In order to fix the pelvis and thorax as a unit to prevent rotation of the spine, the brace is made sufficiently deep for the side bars to lie in the mid-axillary line (Fig. 3C). The appliance is held in place by webbing straps. In addition, a heavy elastic strap is placed at or just below the height of the curve to be corrected (Figs. 3A and 3C). The elastic strap is fitted sufficiently tight to hold the brace snugly against the patient's body, and at the same time loose enough not to give too great a pressure across the back. As illustrated in Figure 3B, the strap which holds the abdominal pad is made of webbing, but, in some instances this strap is of heavy elastic (although the elastic allows abdominal movement, it discourages low-abdominal expansion with respiration). The abdominal pad can be made larger, and, if to encourage thoracic breathing further fixation of the abdomen is desired, an apron may be attached to the brace in place of the pad; however, the author has found the pad to be more satisfactory, as it does not cause the abdominal distress so frequently seen when too great a pressure is exerted above the umbilicus. The pubic and manubrial pads are hinged freely on the two cross pieces, which are fitted in the pectoral and inguinal regions so as not to interfere with movement of the shoulders and hips (Figs. 3D and 3E).

Before the introduction of roentgenotherapy, satisfactory correction of deformities in a patient with Marie-Strümpell disease frequently required many weeks of hospitalization, with the patient recumbent on a Bradford frame. The average length of stay with the combined therapy is now ten days. Thus far correction of the deformities has been satisfactory, and there has been little tendency for recurrence. The patients' general well-being has improved, and the sedimentation rate has been lowered in those patients who have had check-up laboratory studies. In a few instances there has been some recurrence of pain, which has subsided satisfactorily with repeated roentgenotherapy, short periods of bed rest, and the application of local heat. Too short a time has elapsed to determine whether the therapy arrests the disease and prevents further ossification of the ligamentous structures of the spine. Early follow-up roentgenograms have shown no increased calcification in the spinal ligaments, and the patients as a whole have maintained the increase which had been obtained in the range of motion. The most satisfactory results have been in the early cases, but surprisingly good improvement has been noted in some of the patients in whom marked deformity and advanced calcification were present.

The author wishes to thank Chester H. Waters, Jr., M.D., for suggesting the use of the elastic straps; and R. J. Reeves, M.D., for supervising the roentgenotherapy.

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ETIOLOGY OF ASEPTIC NECROSIS OF THE HEAD OF THE FEMUR AFTER TRANSCERVICAL FRACTURE * †

BY EDWARD L. COMPERE, M.D., CHICAGO, ILLINOIS, AND
GEORGE WALLACE, M.D., ROCHESTER, MINNESOTA

Sir Astley Cooper, more than 100 years ago, recognized that the disintegration of the head of the femur which frequently followed fracture of the neck was brought on by disruption of the blood supply to the proximal fragment. Axhansen in 1922 described the microscopic changes of aseptic necrosis of the head of the femur.

Santos studied ten femoral heads, obtained at operation or necropsy following intracapsular fractures, and reported that seven were necrotic and three were viable. Of the seven with necrosis, one had been treated by open reduction and insertion of a beef-bone peg, followed by the application of a plaster cast; each of the remaining six had been treated either by the application of a Whitman cast or by traction, or had had no treatment.

Phemister¹³ studied the fate of the head of the femur in forty-nine cases. Necrosis occurred in thirty-two, while in seventeen the head survived. There was union of the fracture in four of the cases with necrosis of the head. In seventeen of the forty-nine cases, specimens obtained from fifteen days to four and one-half years after injury were studied microscopically. Partial to complete necrosis was found in fourteen.

Most of the material studied by Phemister and Santos was available only because the result of treatment of the fractures had been unsatisfactory. We hazard the opinion that faulty management of some of the fractures may have contributed to the high incidence of aseptic necrosis in their series.

Incidence of non-union resulting from treatment of intracapsular fractures of the hip by methods of external fixation has been found to be very high. Cleveland and Bosworth reported union in nineteen of forty-eight fractures so treated. Santos found that five out of seven femoral heads, removed from hips in which there were old ununited fractures of the femoral necks, were necrotic. These statistics do not answer the question of cause or effect. Did necrosis result in non-union or were inadequate reduction and poor immobilization factors leading to the death of the head?

The primary etiological factor in aseptic necrosis is disruption of the blood supply to the head of the femur. A complete transcervical fracture may rupture the anterior and posterior capsular vessels, which

* This study was made possible, in part, by a grant from the Douglas Smith Foundation of The University of Chicago.

† Read at the Annual Meeting of The American Orthopaedic Association, Baltimore, Maryland, June 6, 1942.

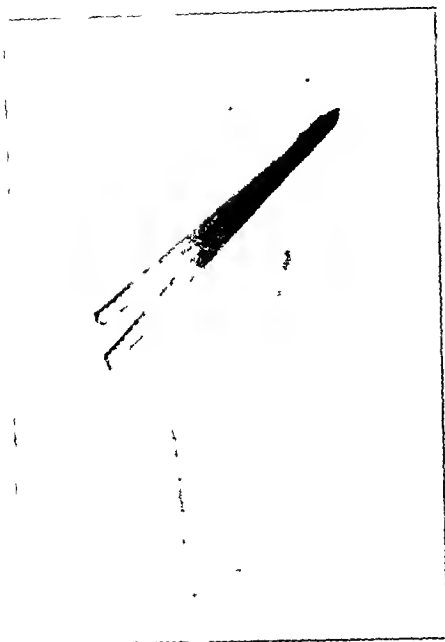


FIG. 1-A

Roentgenogram of proximal end of right femur of Dog 304, removed at necropsy 124 days after fracture, reduction, and accurate pinning. There is bony union, and the head is viable. (See Fig. 1-B.) The left femur of this dog was also fractured, but no reduction or pinning was carried out. The result was complete necrosis and disintegration of the head.

are branches of the circumflex femoral artery. The remaining artery of the ligamentum teres supplies a variable and often relatively small area of the femoral head. Why, then, in some transcervical fractures is there necrosis of the head of the femur, while in others there is complete survival?

The development of techniques for obtaining satisfactory lateral roentgenograms of the hip has undoubtedly resulted in more accurate reduction of transcervical fractures. The teaching of Pauwels has emphasized the importance of relieving the shearing stress by creating a moderate coxa valga position. Secure immobilization of the correctly reduced fragments by means of internal fixation with metal pins, screws, or nails has made union possible in more than 70 per cent. of the cases studied by the Fracture Committee of The American Academy of Orthopaedic Surgeons.⁸ Of 157 cases with bony union, twenty-eight or 17.8 per cent. showed degenerative

changes in the head of the femur similar to those which Phemister¹⁵ and Freund⁹ recognized as the result of aseptic necrosis. The impression might be received from this report of the Fracture Committee that necrosis of the head of the femur has been lessened by the improved

TABLE I
TRANSCERVICAL FRACTURE OF HEAD OF FEMUR, WITH ACCURATE
REDUCTION AND PINNING

Dog	Days after Fracture	Function	Union	Condition of Head of Femur
304 (right) . . .	124	Excellent *	Yes	Viable
351 (left) . . .	93	Excellent	Yes	Viable
568	121	Excellent	Yes	Necrosis
579	121	Good †	Yes	Necrosis
774	106	Excellent	Yes	Viable
780	103	Excellent	Yes	Viable

* Excellent function indicates no demonstrable limp, and normal range of motion.

† Good function denotes slight limitation of motion, but active use of the leg.

management of the fractures. However, a study of a control series of comparable cases in which reduction and immobilization were not satisfactory would be necessary in order to answer this question.

An experiment was planned to try to determine whether or not immediate reduction and complete immobilization by internal fixation of the fragments would influence favorably the incidence of aseptic necrosis of the head of the femur. Dogs were selected as the subjects for the study. In thirty-eight instances the hip joint was opened through an anterior incision, and the neck of the femur was divided with an osteotome. In Series 1 (Table I) the fracture was accurately reduced and pinned with two-threaded or three-threaded, stainless-steel wires, gauge .080, with fifty-six threads to the inch (2.5 centimeters). (See Figures 1-A and 1-B.)

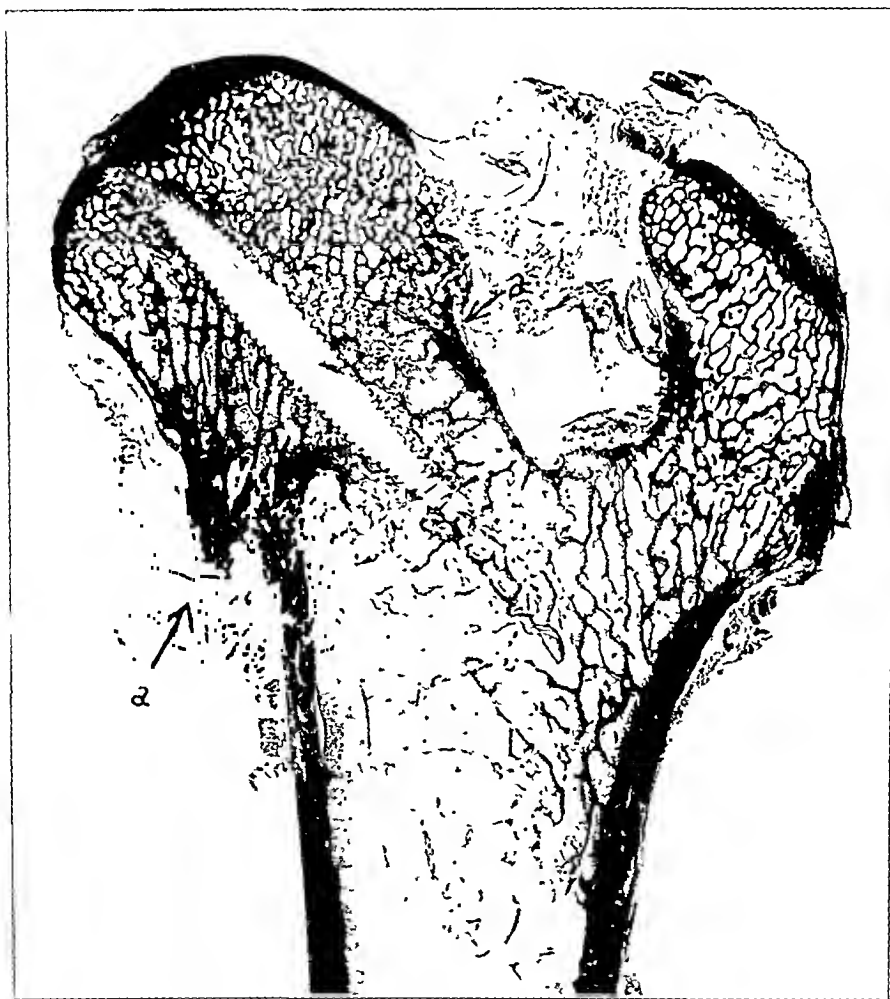


FIG. 1-B

Photomicrographic enlargement of a microscopic section of the right femur of Dog 304. There is normal fatty and hemopoietic marrow throughout. The head is viable. The sharply cut threads made by one of the wires are well demonstrated. The location of the healed fracture is indicated by the arrows.



FIG. 2-A

Roentgenogram of proximal portions of femora of Dog 771. The normal femur is included for comparison. The fracture was poorly reduced. The pins pass from the trochanter to the head. The spotty appearance of the head suggested, and microscopic studies (Fig. 2-B) confirmed, the presence of aseptic necrosis with partial replacement.

These wires have been described⁷, and their clinical use has been reported⁶. In Series 2 (Table II) the fragments were pinned in a position of inadequate reduction (Figs. 2-A and 2-B), while in Series 3 (Table III) the hip was fractured, and no attempt was made to reduce or to immobilize the fragments (Fig. 3).

No cast or other means of external splinting was used. Within from three to ten days, weight was borne voluntarily on the side of the accurately reduced and pinned fracture, and after from two to three weeks it was difficult to detect any limp. Roentgenograms were made at four-week intervals. Union with or without necrosis developed rapidly. A dog matures and ages at a rate that is about five times as rapid as that of man. Roentgenograms made at intervals of four weeks demonstrated

TABLE II

TRANSCERVICAL FRACTURE OF HEAD OF FEMUR, WITH POOR REDUCTION
AND INACCURATE PINNING

Dog	Days after Fracture	Function	Union	Condition of Head of Femur
771.....	104	Good	No	Necrosis
772.....	205	Poor *	No	Necrosis
868.....	119	Excellent	Yes	Viable

* Poor function indicates unwillingness or inability to bear weight on the leg.

that union with or without necrosis of the head was usually definite after eight weeks. Most of these animals were sacrificed within from three to four months after the hip fractures were created.

The loss from infection or distemper was high, and the number of end results studied in the experiments (twenty-one) is not large, but they are consistent and may be regarded as significant. An analysis of the occurrence of union with or without aseptic necrosis is contained in Table IV.

The incidence of necrosis of the head of the femur was high when there was no reduction or when the reduction and internal fixation were not adequate. Yet in two of the six fractures that were reduced and the



FIG. 2-B

Photomicrograph of a section of the ununited fracture of the femur of Dog 771. (See Fig 2-A.) The tracks of two threaded wires are shown. The superior two-thirds of the head of the femur is made up of newly formed, living bone with fine trabeculae. The inferior one-third shows thick, poorly stained trabeculae, which are necrotic and have not yet been absorbed or replaced

fragments pinned, the head was necrotic and partially disintegrated, although there was bony union and function was almost normal (Fig. 4).



FIG. 3

Photomicrograph of a specimen from Dog 908, which consisted of a portion of the ilium (a) including the acetabulum and the head of the femur, which was not immobilized. The articular cartilage (c) over two-thirds of the head is still of normal thickness. The remnant of head has been replaced (d) where blood reaches it through the vessels of the ligamentum teres (L). There is a margin of sclerotic dead bone (e) adjacent to a dense layer of fibrous tissue (b).

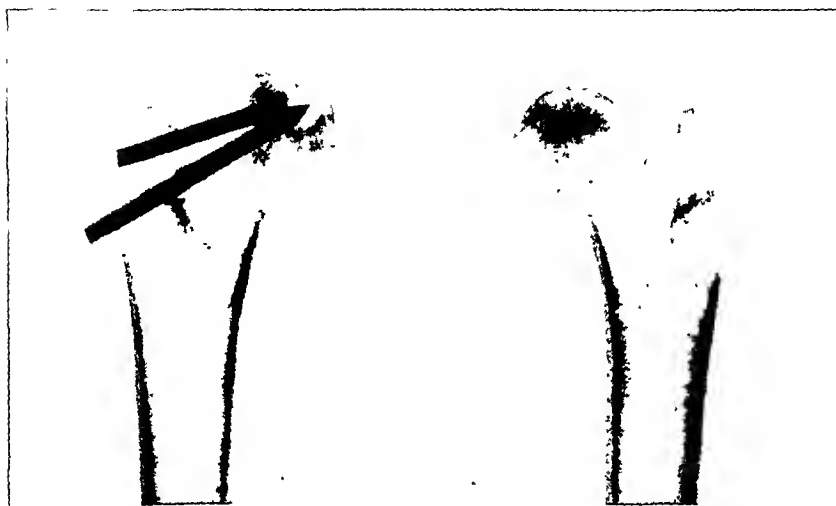


FIG. 4

Roentgenogram of the proximal two-thirds of both femora of Dog 568. After transcervical fracture of one femur, accurate reduction and pinning were carried out. Although union of the fracture followed, the head is necrotic and deformed from weight-bearing. The most advanced absorption and replacement is in the region of the fovea centralis.

DISCUSSION

These experiments indicate that the fate of the head of the femur following transcervical fracture is favorably influenced by immediate accurate reduction and internal fixation. The incidence may be re-

TABLE III

TRANSCERVICAL FRACTURE OF HEAD OF FEMUR, WITHOUT REDUCTION OR PINNING

Dog	Days after Fracture	Function	Union	Condition of Head of Femur
236	104	Poor	Fibrous	Necrosis
304 (left) . .	124	Poor	None	Necrosis
351 (right)..	93	Poor	Fibrous	Necrosis
356	105	Very poor †	Fibrous	Necrosis
777	138	Very poor	None	Necrosis and disintegration
860	114	Poor	None	Necrosis
861	46	Poor	None	Viable
907	91	Good	None	Necrosis and disintegration
908	90	Poor	None	Necrosis
915	106	Fair ‡	None	Irregular atrophy, no collapse
916	132	Poor	None	Necrosis
920 (right) *	83	Poor	None	Viable

* When roentgenograms were made of the pelvis of this dog after operation on the right hip, an old ununited fracture of the left hip, presumably from an accident, was demonstrated. There was necrosis of this femoral head.

† Very poor function denotes no functional use of the leg.

‡ Fair function indicates limited motion, but ability to walk with limp.

TABLE IV
SUMMARY OF TABLES I, II, AND III

Treatment of Fracture	Period between Fracture and Sacrifice	Union		Non-union		Incidence of Survival Per Cent.	Total
		Head Viable	Head Necrotic	Head Viable	Head Necrotic		
Accurate reduction and pinning.	93-124 days	4	2	0	0	66 66	6
Poor reduction and inaccurate pinning.	104-205 days	1	0	0	2	33 33	3
No reduction or pinning.	46-138 days	0	3*	3	6	25 00	12
Total		5	5†	3	8	38.09	21

* Fibrous union only.

† Of these 5, only 2 had bony union.

duced, but aseptic necrosis is not eliminated. In some cases the fate of the femoral head is apparently irreparably sealed at the time of the fracture. This is well demonstrated by clinical cases reported by Phemister¹³ in which impacted fractures of the transcervical neck of the femur healed, but the head was necrotic and subsequently disintegrated.

Phemister¹⁴ believes that the fate of the head is determined at the time that the fracture occurs and depends almost entirely upon the amount of tearing of the capsular blood vessels or upon the amount of blood distributed to the head through the round ligament. Phemister¹⁵ has expressed the opinion that the relative decrease in the incidence of aseptic necrosis following immediate reduction of the fracture and pinning of the fragments must result from the fact that some of the posterior capsule with its blood vessels remains intact when the neck is fractured. In the unreduced fractures, friction and motion between the fragments may complete the rupture of this posterior capsule and hence result in a higher incidence of necrosis.

Factors which may influence the survival of the femoral head, besides the location of the fracture, include the following: age of the patient, displacement or impaction of the fragments, open or closed reduction, accuracy of the reduction, immediacy of the reduction, elimination of sheering force on fracture line, adequacy of fixation, and choice of materials used in internal fixation.

Multiple minor traumata, produced by the stresses and strains of the daily use of the weight-bearing extremities, have been blamed for aseptic necrosis which occurs as a precursor of flattening or disintegration of the head in *malum coxae senilis*. Such changes may occur at a much earlier

age if the mechanics of the hip joint are faulty. Aseptic necrosis of the hip has been observed in young adults following closed reduction, during infancy or early childhood, of a congenitally dislocated hip; in association with coxa plana that resulted from Legg-Perthes disease; and in cases of congenitally inadequate acetabulae. Freund¹⁰ has reported the experimental production of osteochondritis dissecans (which is a localized aseptic necrosis) by multiple minor traumata.

The theory of Phemister that the fate of the head following fracture of the transcervical neck is decided *entirely* on a basis of injury to the blood supply to the head at the time of fracture, or by additional tearing of blood vessels in the posterior capsule if weight-bearing is permitted before union takes place, ignores the factors of disturbed mechanics of the hip as well as the theory of minimal traumata. Although it will be difficult to prove, it does seem reasonable to assume that in some cases following fracture the femoral head *may survive*, but with little more than enough blood supply to maintain viability without the stresses and strains of weight-bearing activity. If minimal traumata can produce changes of aseptic necrosis in the head of a femur in which there has been no fracture or dislocation, it would not be illogical to *anticipate* late necrosis in the head of a femur which has survived the fracture and united following reduction. This would be more likely to occur if the mechanics of the hip joint were faulty because of poor reduction and malunion of the fragments.

That old age is not a primary etiological factor is shown by the report of Wilson and that of Carrell and Carrell; these authors observed the frequent occurrence of aseptic necrosis in the head of the femur in children following transcervical fracture. A review of the study of twelve hips reported by Carrell and Carrell leads to the interesting observation that of five hips in which the initial reduction was unsatisfactory, aseptic necrosis developed in three, and a fourth hip became ankylosed. Of seven hips in which the fracture was initially accurately reduced and adequately immobilized, aseptic necrosis developed in only one. The fact that the results described as "fair" and "poor" were reported from four to fifteen years after fracture, while the postfracture period of those classed as "good" was only from one to two years, may be as significant as the question of management of the fresh fracture.

King, in reporting a very comprehensive study of final results in recent and old intracapsular fractures of the femoral neck, has stated that those which have not been reduced and immobilized within three weeks after fracture should be arbitrarily called old and ununited. He adds that, lacking contact with the vascular distal fragment, the head of the femur will not survive as often as when early reduction and fixation of fragments are carried out. The experiments which we have reported support this hypothesis.

Banks has reported necrosis of the head of the femur following traumatic dislocation without fracture. Such dislocations are accom-

panied by complete rupture of the ligamentum teres, but the extent of injury to the capsular vessels has not been determined. Necrosis following simple traumatic dislocations suggests that the blood supply via the ligamentum teres is more important than has been generally recognized.

Those who have studied the end results of fracture of the transcervical neck of the femur in any considerable number of cases will have observed at some time necrosis with collapse of the head, which has become manifest years after healing of the fracture. Union of a fracture of the neck of the femur, regardless of the method of reduction or of immobilization, does not of itself constitute an end result. The condition of each head of the femur should be studied at intervals for at least five years after union and beginning weight-bearing by those surgeons who are qualified by training and experience to recognize roentgenographic changes and to interpret them in terms of pathological processes such as aseptic necrosis.

SUMMARY AND CONCLUSIONS

Necrosis of the head of the femur occurs less often if the fracture of the transcervical neck is immediately and accurately reduced and adequately immobilized.

In the experiments carried out by the authors, necrosis with collapse of the weight-bearing portion of the cortex of the head occurred in two of six cases following accurate reduction of the fracture and pinning of the fragments, although the fracture united. In these two cases the head of the femur may have been viable when union occurred, but, with partially depleted blood supply, the minimal traumata of continued use and weight-bearing may have resulted in the necrosis and disintegration.

The prognosis for survival of the head of the femur is definitely less satisfactory if the reduction of the fracture is not anatomically correct or if pinning of the fragments is not adequate for complete immobilization.

Death of the head of the femur when the fracture was neither reduced nor immobilized was found to occur in nine of twelve hips studied. It is possible that weight-bearing activity and friction between the fragments may have ruptured blood vessels that were left intact after fracture in a portion of the posterior capsule. However, this theory does not explain the difference in incidence of necrosis in cases in which the head was pinned without accurate reduction and in those in which the head was pinned in an anatomically correct position.

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MEASUREMENTS OF THE STRENGTH OF TRUNK MUSCLES *†

BY LEO MAYER, M.D., AND B. B. GREENBERG, M.D., NEW YORK, N. Y.

From the Hospital for Joint Diseases, New York

When in 1932 Lowman presented his paper on the reinforcement of weak abdominal muscles by fascial grafts, he stimulated an interest in one of the major factors causing paralytic deformities. Particular credit is due him, since, until then, scant attention had been paid to the study of paralyzed abdominal muscles, although one of us (L M) had indicated their importance in a paper on "Fixed Paralytic Obliquity of the Pelvis", published in January 1931. Lowman described certain tests which he made to determine the strength of these muscles, and additional modes of estimating their power were recorded by the senior author in a second

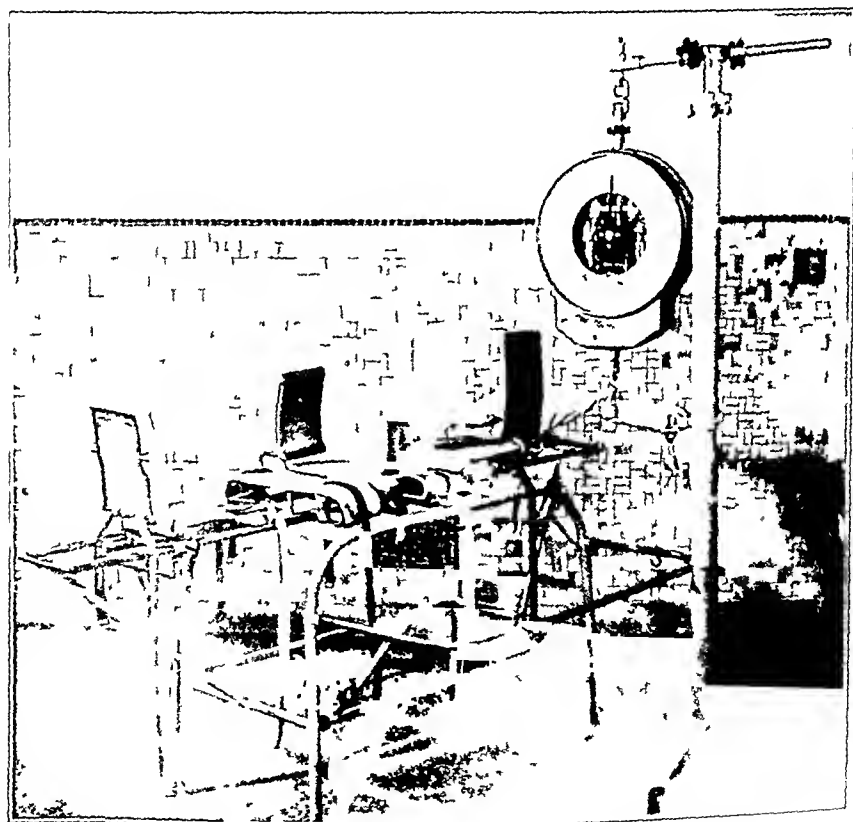


FIG 1

Photograph of swivel table, showing the scale clamped to the side bar.

* Read at the Annual Meeting of The American Orthopaedic Association, Baltimore, Maryland, June 5, 1942

† This research was aided by a grant from The National Foundation for Infantile Paralysis, Inc

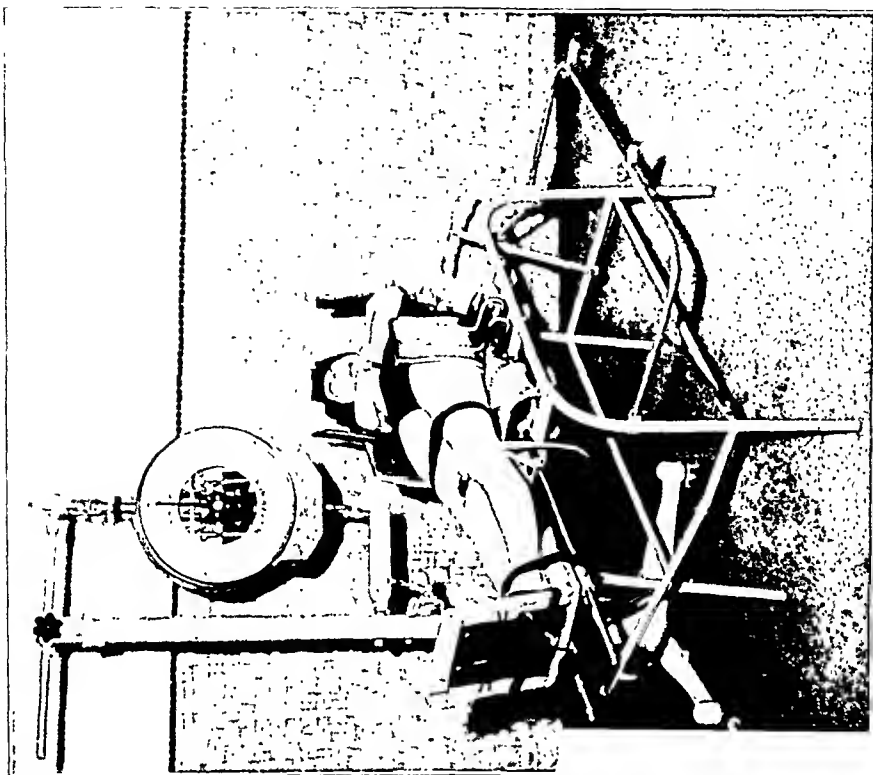


Fig. 3

Patient is strapped to the table preparatory to testing the left lateral trunk muscles. The body has been bent toward the right, so as to put the left lateral trunk muscles on the stretch.

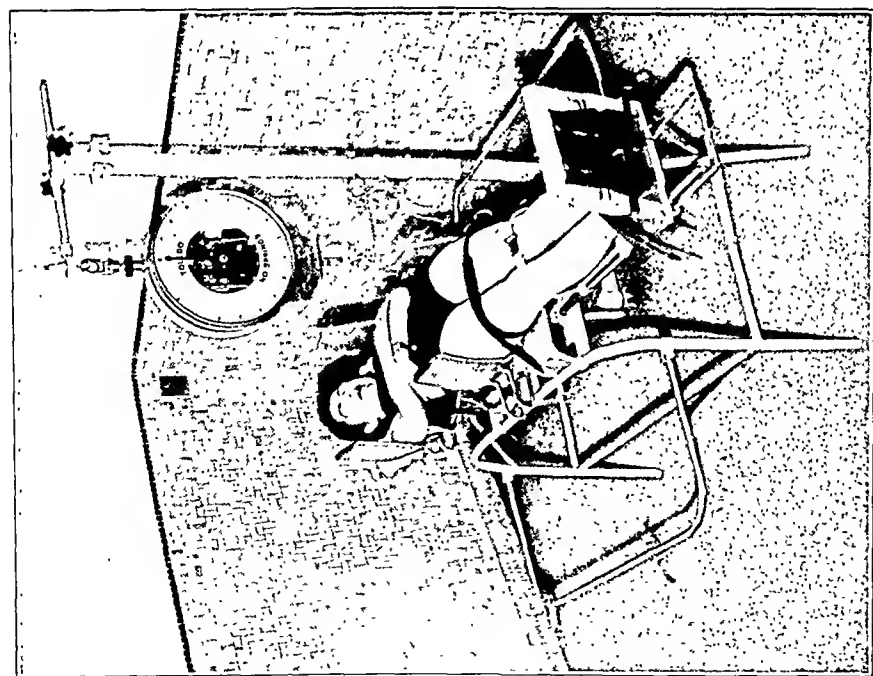


Fig. 2

Patient is strapped to the table. The body is in the neutral position preparatory to the tests for the right lateral trunk muscles.

paper entitled "Further Studies of Fixed Paralytic Pelvic Obliquity", published in January 1936. These methods, although of some value, were from their very nature essentially subjective,—that is, dependent upon the judgment of the particular surgeon who made them. The criterion which was applicable to muscles of the extremities—namely, the power to contract against the weight of the limb—could not be used for the trunk muscles. Consequently, trunk muscles were graded as "good", or "fair", or "poor" in a rather haphazard fashion.

To overcome this obvious weakness in our methods of examining patients suffering from the residual paralysis of poliomyelitis, we have devised a method, which, so far as we can tell at present, gives us valuable information. The essential is a swivel table (Fig. 1), a refining of a crude model made by one of us, shown in Figure 8 of the second article on pelvic obliquity. The original wood has been replaced by metal, the clumsy pivot by ball bearings, the inaccurate recording system of a spring balance attached to ropes running over pulleys by a precise gravity scale, but the essential principle of our present method is the same as that of the original procedure. The new table consists of two parts,—a stationary foot-piece and a movable body-piece so mounted that it can swing from side to side on ball bearings with minimal friction. The legs can be firmly strapped

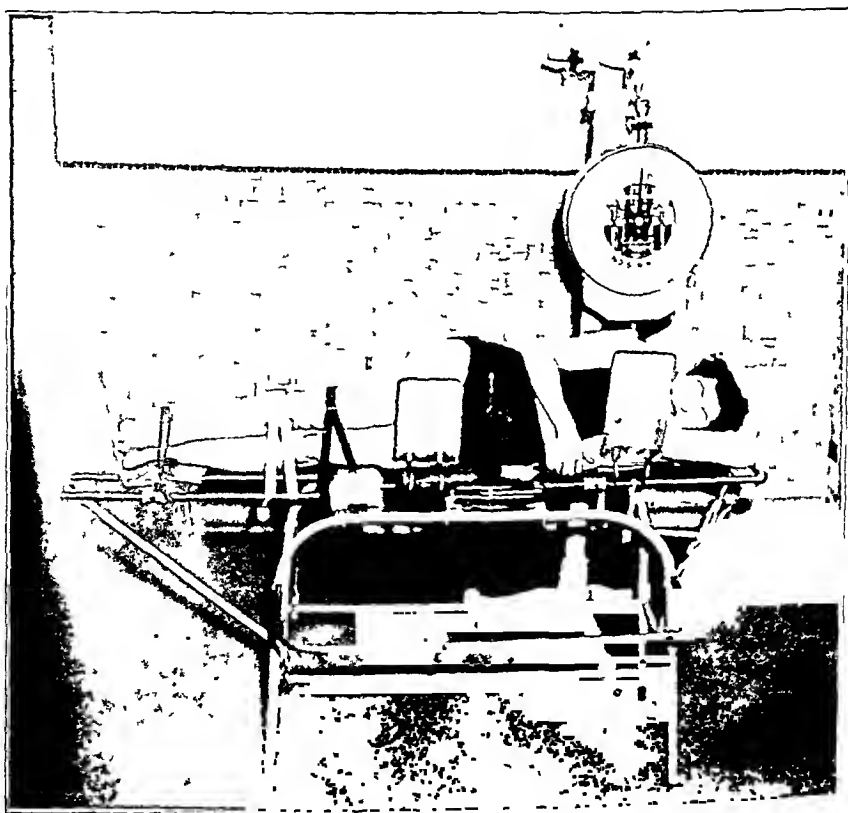


FIG. 4

Patient is in the neutral position for testing the flexor muscles of the trunk.

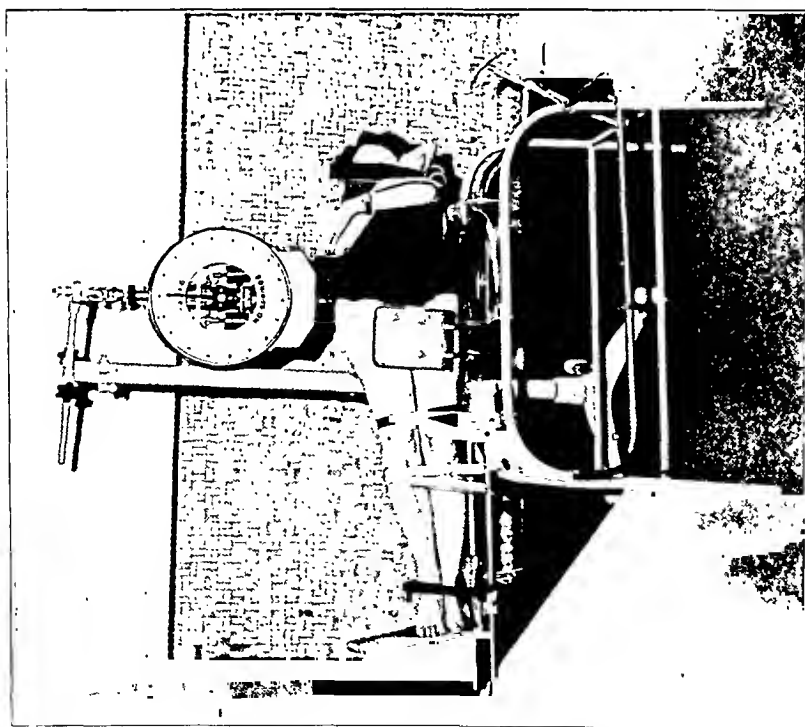


FIG. 5

Patient is in the hyperextended position preparatory to testing the flexor muscles. These have been put on the stretch by the hyperextended position.

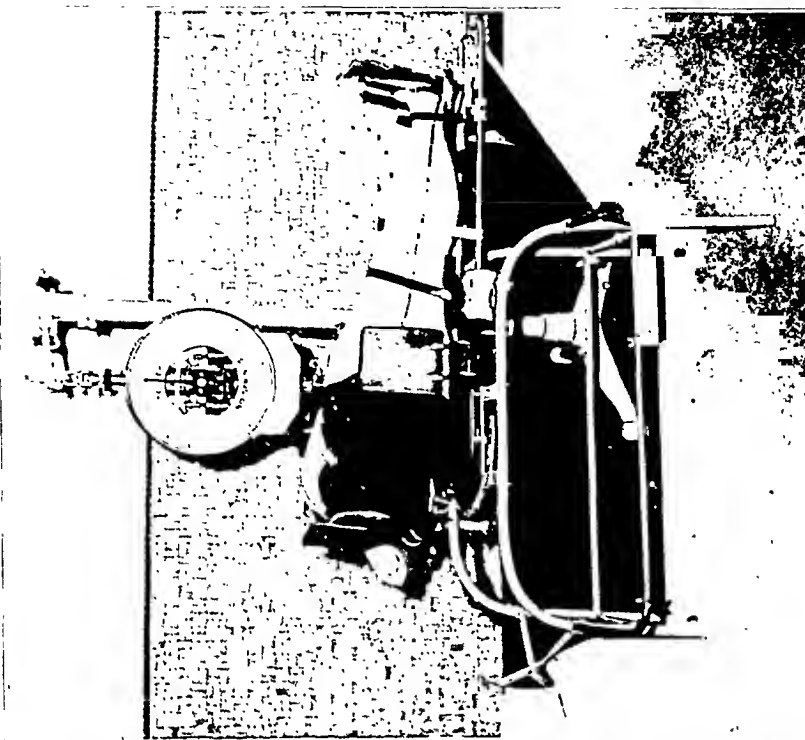


FIG. 6

Patient is in position preparatory to testing the extensor muscles of the trunk. The body has been flexed to put the extensor muscles on the stretch.

GRAPH OF COMPARATIVE STRENGTH OF RIGHT LATERAL TRUNK MUSCLES,
CONTRACTING FROM NEUTRAL AND FROM STRETCHED POSITIONS

Pounds

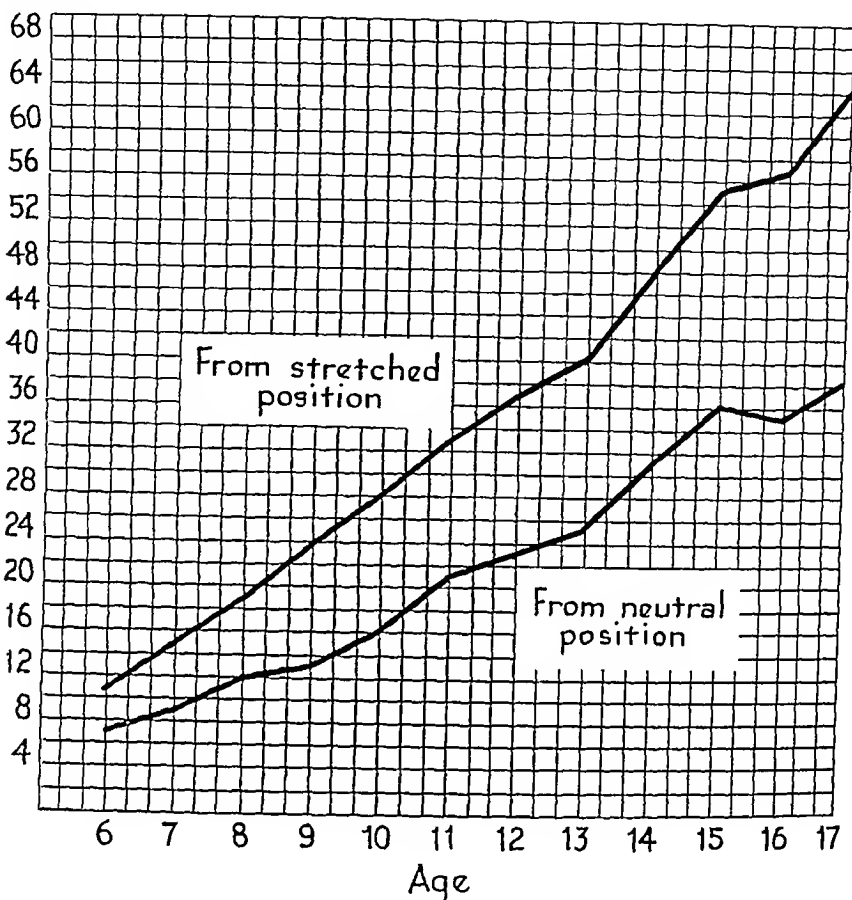


FIG. 7

This graph illustrates the increased power of the lateral trunk muscles when put on the stretch.

to the foot-piece; the pelvis is supported by adjustable leather pads; and the body is held securely in place by straps and chest pads. A steel cord runs from the side of the body section of the table to the scale, which is locked in position by a clamp attached to an adjustable horizontal bar. This type of recording device is far more accurate than the spring-balance method of Lovett, which we used for more than a year before convincing ourselves of its inaccuracy. The spring balance permits too much subjective variation in the hands of different examiners, and too great a range of body motion with a consequent shift of the angle of force application and a variation in the strength of the contracting muscles. Because of these variations, numerous discrepancies were noted, which forced us to discard our measurements made by this method in 300 cases. The gravity scale, when fixed to the horizontal bar, eliminates these variations and gives consistent readings with different observers.

GRAPH OF STRENGTH OF RIGHT LATERAL TRUNK MUSCLES OF 550 NORMAL BOYS
AND GIRLS. TRUNK SWINGS TO RIGHT FROM NEUTRAL POSITION

Pounds

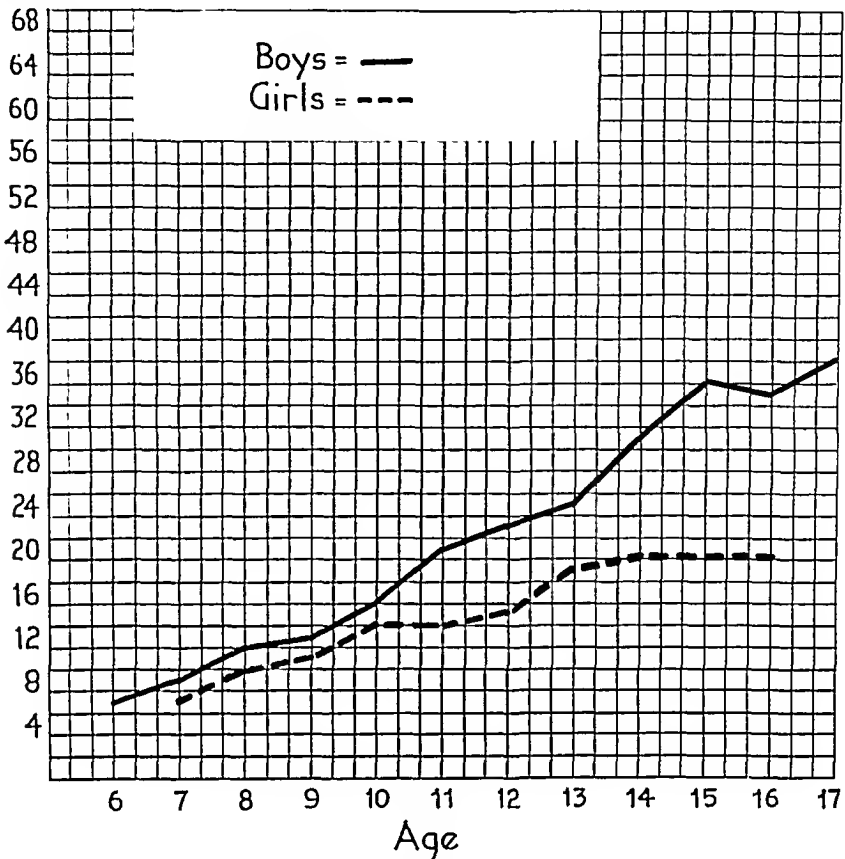


FIG. 8

This graph illustrates the difference in the muscle strength of boys and girls. The girls do not increase in strength after the fourteenth year, whereas the boys continue to gain.

It is of course obvious that this method of measuring muscle strength applies to groups of muscles, and not to an individual muscle. It is possible to measure the strength of the lateral flexors of the trunk of the right and left sides, the extensors, and the trunk flexors, but not of the rectus abdominis or of the obliquus externus abdominis. Even the muscle groups, however, do not act with complete independence; thus, when the extensors of the trunk contract against a strong resistance, the legs are braced by the thigh and calf muscles, and even the arm muscles try to aid the trunk. To this degree, our method is inaccurate, but in this very fact lies an important practical application of the test, for the normal action of the trunk muscles is invariably coordinated with action of the muscles of the extremities. Thus, in lifting a weight—predominantly an action of the trunk extensors—the legs must be braced and the arms held

GRAPH OF STRENGTH OF RIGHT LATERAL TRUNK MUSCLES OF 550 NORMAL BOYS AND GIRLS. TRUNK SWINGS TO RIGHT FROM LEFT LATERAL FLEXION

Pounds

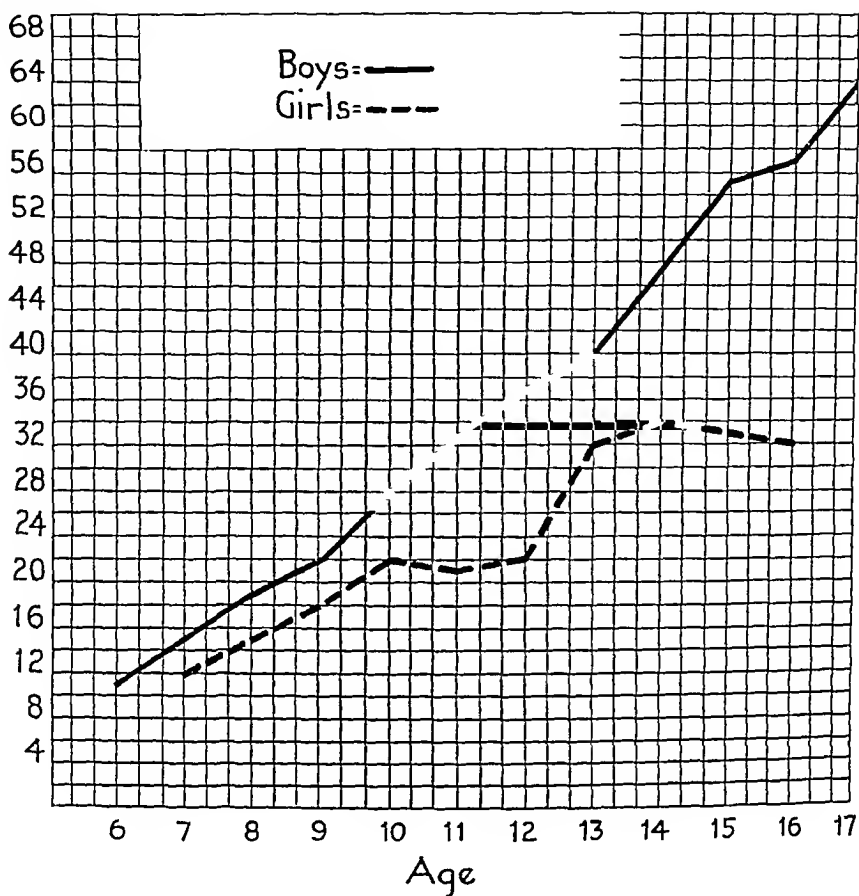


Fig. 9

This graph also illustrates the marked difference in muscle strength between the boys and the girls.

taut. Our test, therefore, serves to give an accurate idea of the strength of the body in performing certain actions.

Although our primary object was the measurement of pathological muscles, the normal had to be studied first in order to set up a table of norms. To do this, measurements were carried out on 550 children, ranging in age from seven to seventeen years. The following tests were made: The child was strapped to the table in the supine position (Fig. 2) and was then asked to swing the body to the right. This body effort was transmitted through the steel cord to the scale and gave a reading in pounds. The test was repeated a few times until the child understood just what was expected of him, and then two final readings were taken. The actual excursion of the table during the test is extremely slight,—not more than 5 degrees; therefore, the line of force does not vary much from the perpendicular. We soon found that the strength of the muscles

GRAPH OF STRENGTH OF FLEXOR MUSCLES OF 550 NORMAL BOYS AND GIRLS.
TRUNK SWINGS FORWARD FROM NEUTRAL POSITION AND FROM
HYPEREXTENDED POSITION

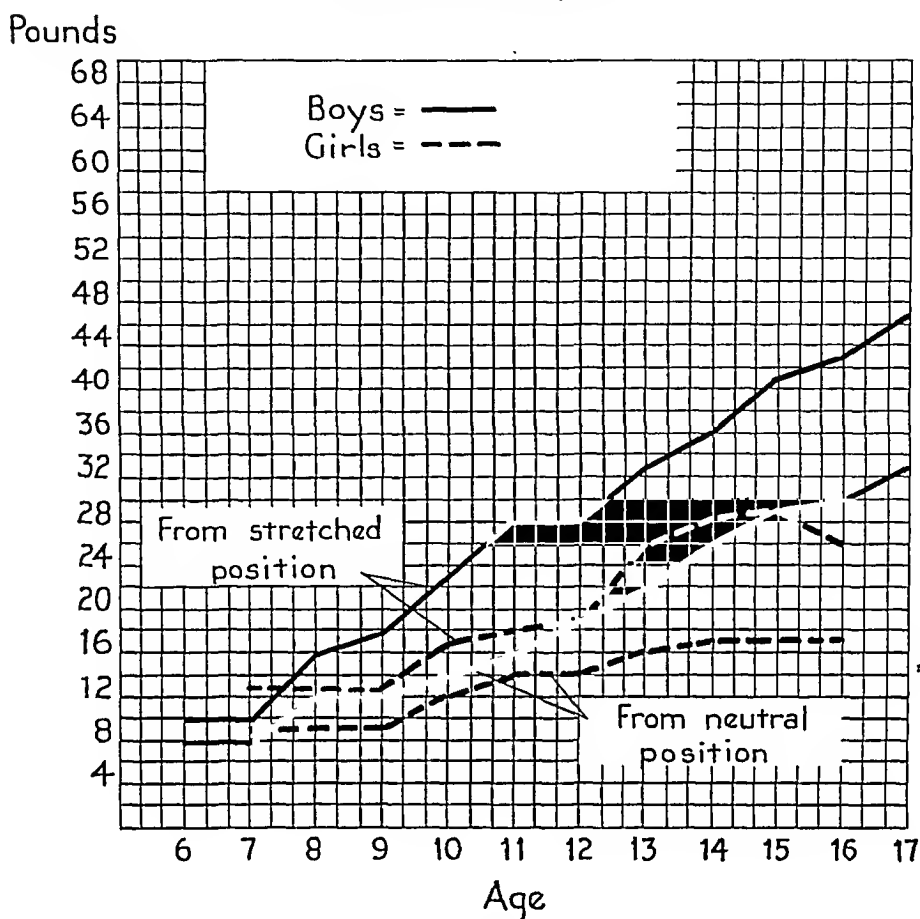


FIG. 10

This graph shows that the power of the flexor muscles is definitely less than that of the lateral trunk muscles.

varied considerably with the position of the trunk at the start of the test. Thus, if the body was first bent strongly to the left, so as to put the right lateral trunk muscles on the stretch, these muscles showed much more power than when the starting position was the neutral mid-line. It thus became evident that the groups of muscles would have to be tested from two positions,—a neutral or so-called resting position and a stretched position in which the muscle fibers were passively elongated to their normal limit. Let us here point out that we are not attempting to record the so-called moment of the muscles,—that is, the product of their contractile power multiplied by the range of the contraction. We are only recording the muscle strength during one small phase of its contraction,—namely, through an arc of about 5 degrees.

After the right lateral trunk muscles were tested from the neutral

and the stretched positions, the left lateral trunk muscles were recorded (Fig. 3). For gauging the flexors and extensors, the children were placed on their sides, first on the right and then on the left (Fig. 4). For both groups, tests were made from the neutral position and from the stretched position (Figs. 5 and 6).

The records of the 550 children examined were grouped according to

GRAPH OF STRENGTH OF EXTENSOR MUSCLES OF 550 NORMAL BOYS AND GIRLS.
TRUNK SWINGS BACKWARD FROM NEUTRAL AND FROM EXTREME FLEXION

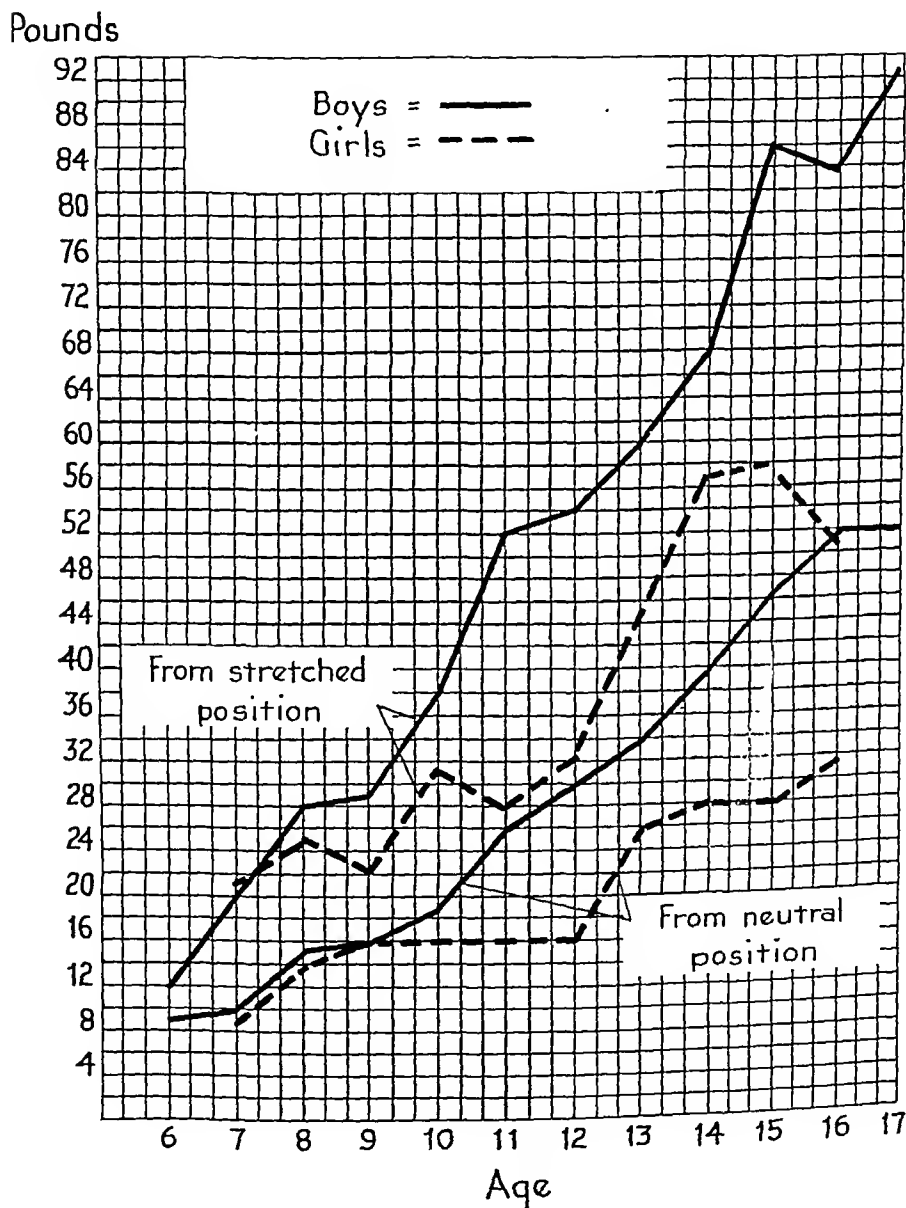


FIG. 11

Showing that the extensor muscles are stronger than the lateral trunk muscles.

age and sex. Tabulations were then made, so as to get the average of each muscle group for each age and sex. By this method graphs were constructed which gave us a table of norms by means of which pathological variations in muscle strength could be estimated (Fig. 7).

These graphs have given us information which may be of some significance, not only for the interpretation of paralytic conditions, but in

GRAPH OF COMPARATIVE STRENGTH OF LATERAL TRUNK MUSCLES, FLEXORS, AND EXTENSORS OF 250 NORMAL BOYS CONTRACTING FROM THE STRETCHED POSITION

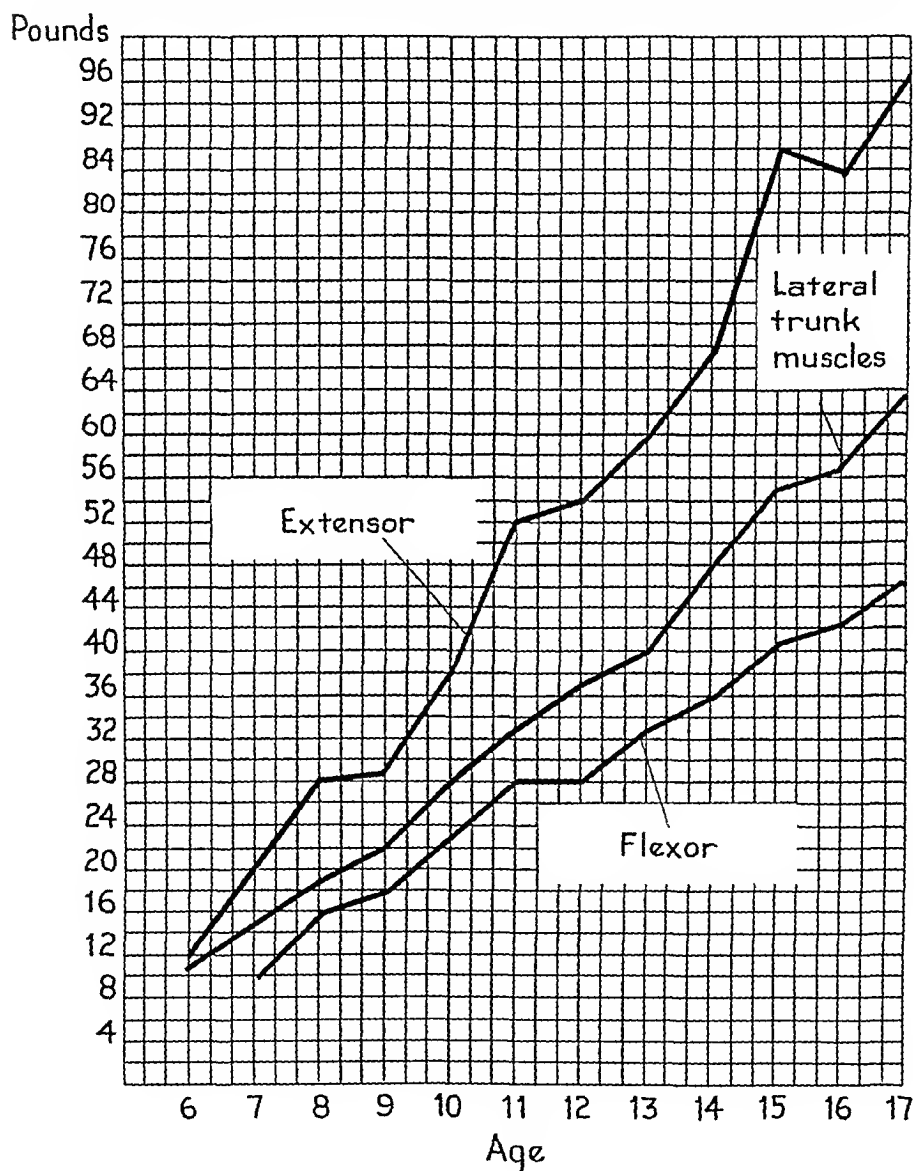


FIG. 12

This graph shows that the strength of the lateral trunk muscles is between that of the flexors and the extensors. The ratio of the three groups is approximately 3:4:6.

the study of posture and the evolution of scoliosis. In all, there was a striking difference between the boys and girls. The two sexes parallel one another rather closely until the fourteenth year; then there occurs a marked disparity. The graph of the girls forms a horizontal line, whereas the graph of the boys ascends steeply (Figs. 8 and 9). In other words, the seventeen-year-old girl has no more strength in the trunk muscles than has the fourteen-year-old, but the boys developed more rapidly during these three years than during any other comparable period. Thus it happens that the seventeen-year-old boy has almost always twice as much strength as the girl of the same age.

A fairly constant ratio has been found between the strength of the trunk flexors and that of the trunk extensors. The extensors are invariably more powerful, and the ratio is almost two to one. Midway

GRAPH OF COMPARATIVE STRENGTH OF RIGHT AND LEFT LATERAL MUSCLES OF 250 NORMAL BOYS. TRUNK SWINGS FROM NEUTRAL POSITION

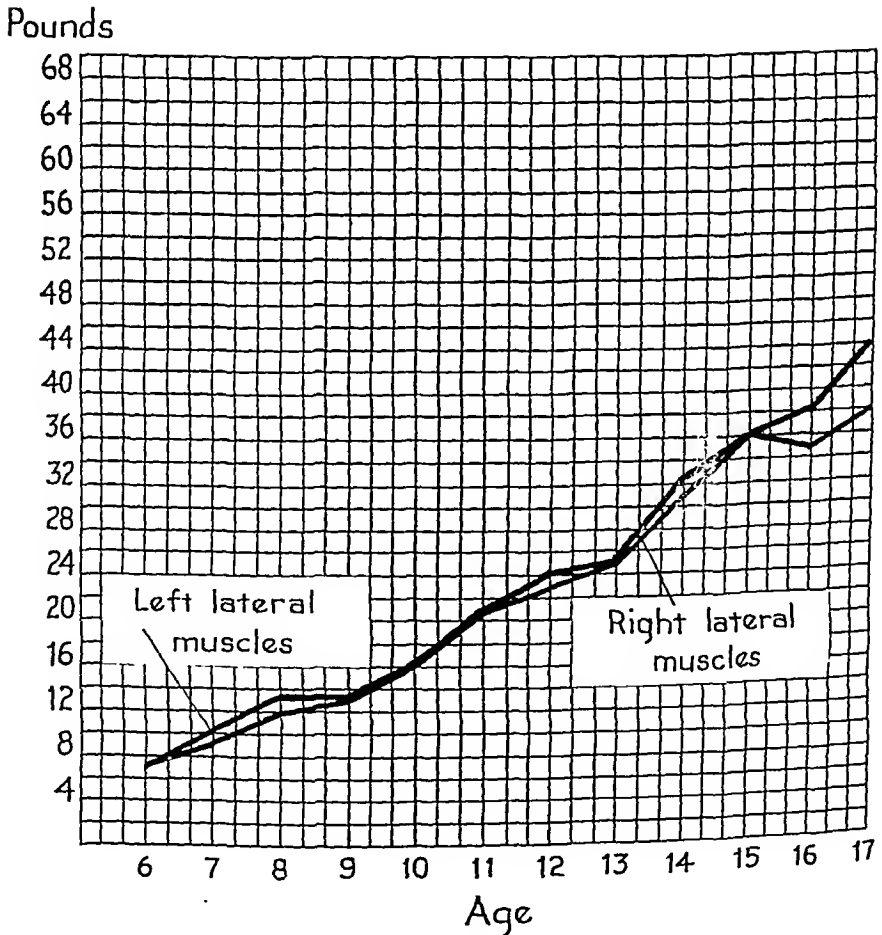


FIG. 13

This shows that there is slightly more strength in the left lateral muscles than in the right lateral muscles. This may be due in part to the slight extra strength of the right leg and arm, which are used in supplementing the left lateral trunk muscles.

between these two are the lateral trunk muscles. (See Figures 10, 11, and 12.) This relationship makes it easy to detect pathological variations due to paralysis of one group.

We had expected an accurate correspondence of the muscles of the right side with those of the left side, but, to our surprise, we found that the left lateral group throughout the series had a slight predominance over the right (Fig. 13). It must be remembered, however, that these tests are not records of the trunk muscles alone, for the leg and arm muscles are also used, although to a lesser degree. As the left trunk muscles contract, the right thigh and right arm brace against the fixation pads. It may well be, since most of the children examined were right-handed, that the discrepancy in power between the right and left trunk muscles was due, in part at least, to the predominance of the right extremities over the left. Irrespective of this explanation, the fact remains that in 550 normal children the muscle strength in the two sides does not exactly correspond. To us this was a new fact which we wish to check by additional observation and careful controls. If it is true, it may serve as an important factor in the development of the so-called idiopathic scoliosis.

About fifty cases of poliomyelitis were studied. Almost all were in the chronic stage. The strength of the trunk muscles had been graded from zero to five, according to clinical methods already published. When these grades were compared with the tests on the swivel table, many discrepancies were found. Our results can best be summarized by citing a few typical instances:

Richard R., aged six (Fig. 14). In this patient both legs were extensively paralyzed, and the trunk muscles had been graded as follows: right lateral, 2—; left lateral, 4; flexors, 3—; extensors, 4—. Despite the difference in the strength of the right and left lateral muscles, no pelvic obliquity or scoliosis had developed during a period of five years since the onset of the paralysis.

These observations did not accord with what we had seen in other similar cases, since usually, with this difference in the strength of the lateral muscles of the two sides, pelvic obliquity and scoliosis had been the rule. The swivel-table test showed that our clinical examination was incorrect. The difference between the right and left sides was extremely slight,—namely, one pound. The extensors which had been rated 4—

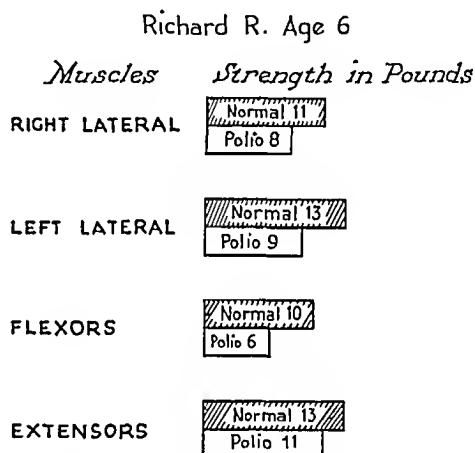


Fig. 14

This chart of a poliomyelitis patient shows the comparison in the strength of paralyzed and normal muscles. In this case pelvic obliquity or scoliosis failed to develop, largely because the right and left lateral muscles are almost of the same strength, and the three groups of muscles have preserved their normal ratio.

Joseph G. Age 9

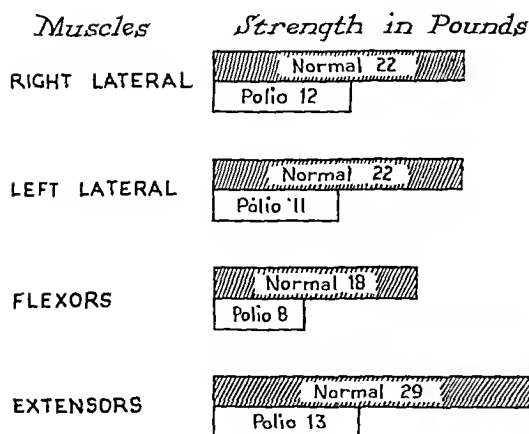


FIG. 15

In this chart of a poliomyelitis patient, a boy, aged nine, the muscle strength corresponds accurately to that of a child of six.

tion in the normal relationship between the strength of the lateral muscles and the flexors and the extensors.

Since this child of nine had approximately the same strength as a six-year-old, obvious conclusions were necessary with regard to the treatment and the physical response which we might expect.

Harriet R., aged thirteen (Fig. 16). In this patient the clinical test showed a forward tilting of the pelvis and a marked lordosis, due to a weakness of the abdominal muscles. These muscles had been rated as follows: lateral, 3; anterior, 2. The patient

Harriet R.

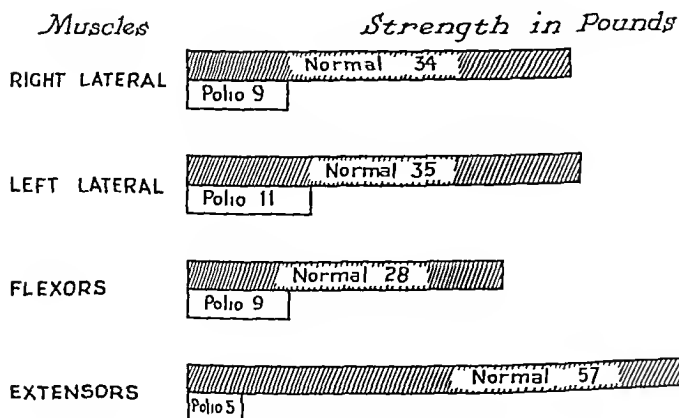


FIG. 16

This chart of a poliomyelitis patient shows that, although the clinical tests emphasized the weakness of the abdominal muscles, resulting in a sagging of the abdomen and increased lordosis, the most marked weakness was of the extensor muscles of the trunk.

were in reality almost normal. The swivel table helped us to explain why Richard had not developed pelvic obliquity and scoliosis.

Joseph G., aged nine (Fig. 15). This boy had an involvement of the right foot, with good hip muscles and apparently good trunk muscles, which we had rated as 5. The swivel table proved that we had overestimated their strength. The flexors proved to have 44 per cent. of the normal strength; the extensors, 45 per cent.; the left lateral 50 per cent., and the right lateral 55 per cent. When the strength of his muscles was compared with that of a six-year-old child, it was found that they were almost the same. There was a varia-

Nancy A.
Paralysis of right lateral abdominals
following fascial transplant.

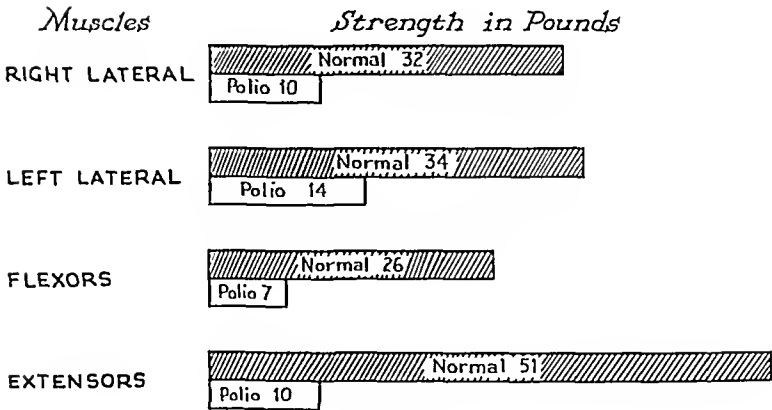


FIG. 17

In this case there had been a complete paralysis of the right lateral trunk muscles, resulting in a fixed paralytic pelvic obliquity. The right side was four inches lower than the left. Following a fascial transplantation, running from the right ilium to the ninth rib on the right side, the pelvic obliquity was markedly reduced, and the patient, who previously had been unable to stand alone, was able to walk a half mile and climb a flight of steps. The improvement is indicated in the chart, which shows considerable strength in the right lateral trunk muscles.

also had a progressive scoliosis and her extensor muscles were rated as 3. The swivel table, however, gave us another impression. This test showed that the extensors were much weaker than the other trunk muscles. They had a pull of only five pounds as compared with the normal fifty-seven pounds, or less than one-tenth of normal strength; whereas the flexors, though weak, had one-third of normal strength, and the laterals had little more than one-quarter. Recently two operations have been performed on this patient,—a spine fusion and bilateral fascial transplantations.

It will be illuminating to observe the effect of these operations.

In two cases we have had a chance to make tests following fascial transplantations to reinforce weak or absent abdominal muscles.

Nancy A., aged sixteen (Fig. 17). This patient had a pelvic obliquity of four inches, due to an

Lillian M.
Following bilateral fascial transplants
to replace paralyzed abdominal muscles

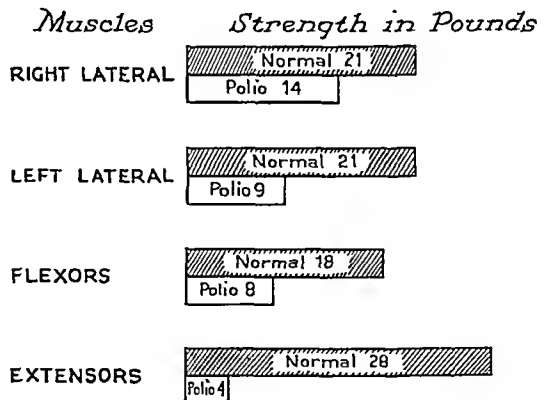


FIG. 18

In this case bilateral fascial transplantations were done to support the weakened abdominal muscles. The fascial strips ran from the ilium to the ninth rib on both sides. The chart shows that the abdominal muscles have improved markedly, although the extensors are still far below the normal strength.

almost complete absence of the right lateral abdominals and the right quadratus lumborum. After the fascial transplantation, the pelvic obliquity was reduced to one inch, and the patient, who previously could not walk alone, was able to walk a half mile and climb a flight of steps. The swivel table showed that the right lateral abdominals had approximately one-third of normal strength, and the left only a little more (two-fifths of the normal). In other words, the fascial transplantation had done much to re-establish muscle balance.

Lillian M., aged twelve (Fig. 18). This patient had bilateral abdominal paralysis, resulting in marked sagging of the abdominal wall, forward tilting of the pelvis, and extreme lordosis. Bilateral fascial transplantations were done, resulting in marked improvement. This was evident by the swivel-table tests, which showed the paralyzed flexors to have almost one-half the normal strength.

We conclude from our observations that in the swivel table we have a means of evaluating power of trunk muscles more accurately than by the previous clinical tests. There is a chance that through these tests we may be able in the future to learn more about the cause of postural defects, painful backs, and scoliosis, as well as about the residual paralyses of poliomyelitis.

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THE OBTURATOR SIGN AS THE EARLIEST ROENTGENOGRAPHIC SIGN IN THE DIAGNOSIS OF SEPTIC ARTHRITIS AND TUBERCULOSIS OF THE HIP *

BY HANS W. HEFKE, M.D., AND VERNON C. TURNER, M.D.,
MILWAUKEE, WISCONSIN

From the Milwaukee Children's Hospital

In the anteroposterior roentgenographic examination of the pelvis and hip, a soft-tissue shadow may be seen just medial to the acetabulum on the inner aspect of the pelvis (Fig. 1). The border of this shadow ordinarily starts from a point lateral to and below the lower pole of the

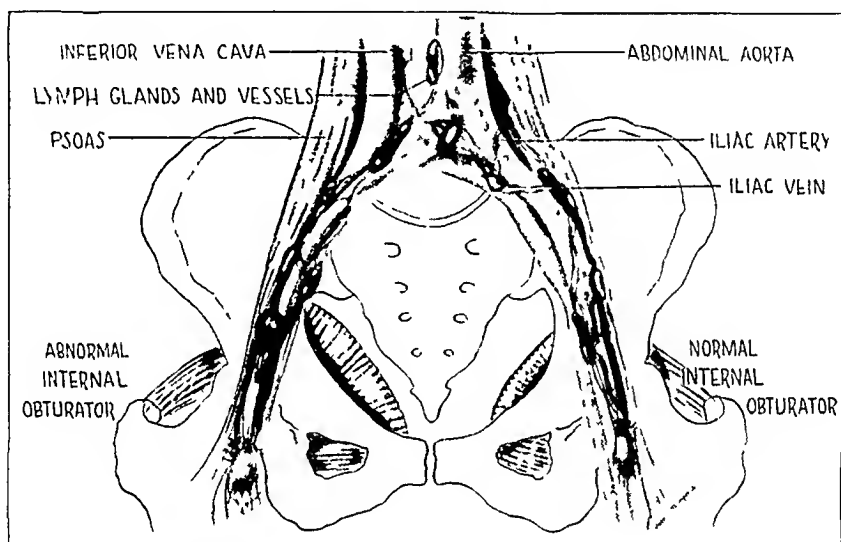


FIG. 1

Anatomical sketch of normal (left) and abnormal (right) obturatores interni and their relationship to pelvic structures.

sacro-iliac joint, follows the line of the pelvic inlet downward over the acetabulum, and disappears behind the upper ramus of the pubis. This shadow in normal children measures from two to eight millimeters at its widest point. Usually the shadow on one side corresponds in width to the shadow on the other. There may be, however, a minimal difference in width of this shadow in normal individuals.

It has been noted that certain changes occur in the contour of this shadow in cases of septic arthritis and in tuberculosis of the hip.

It is the purpose of this study to determine the anatomical basis for this shadow and its importance in the early roentgenographic diagnosis of pathological conditions about the hip.

* Read at the Annual Meeting of The American Academy of Orthopaedic Surgeons, Atlantic City, New Jersey, January 13, 1942.

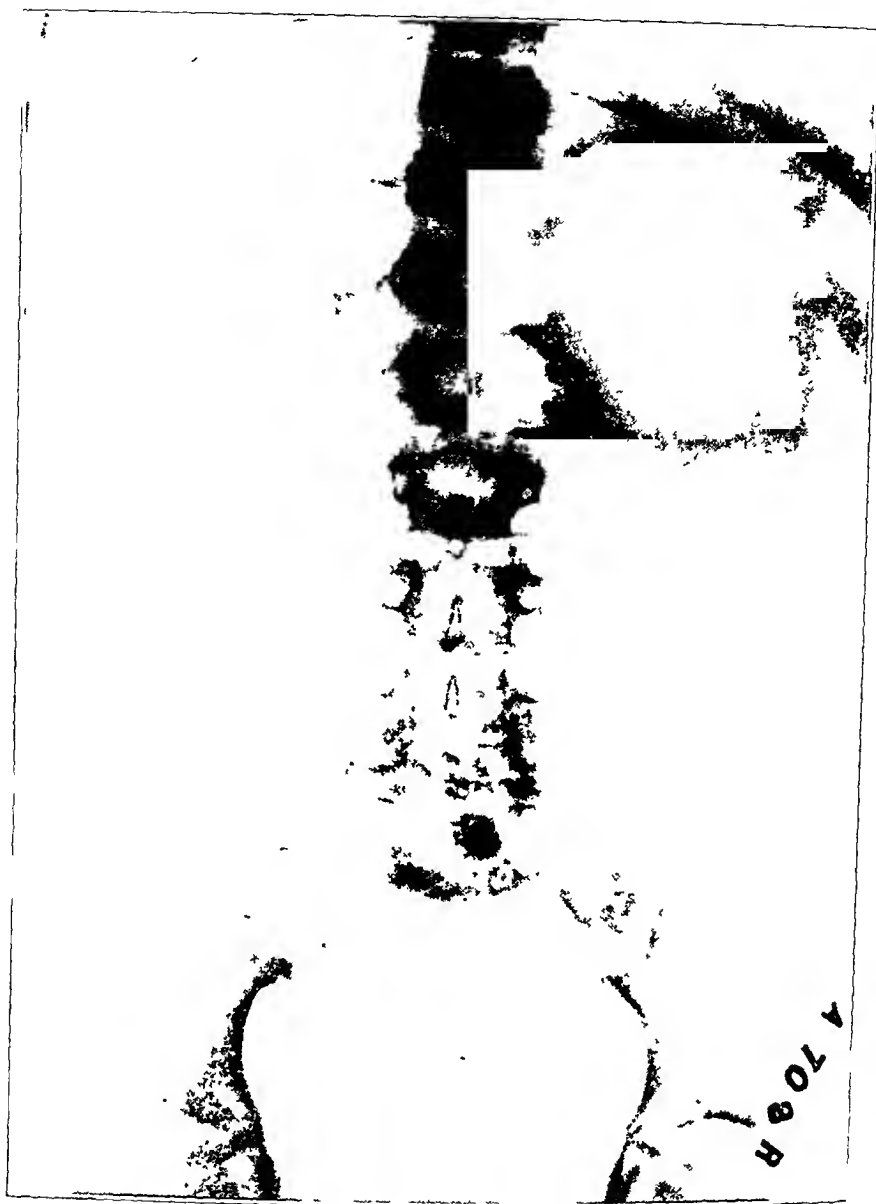


FIG. 2

Tuberculosis of the spine with a partially calcified psoas abscess overlying the obturator shadow on the right (postero-anterior view).

The shadow is not entirely unknown, even though no direct mention of it, as such, could be found in the literature. It has been used by some roentgenologists as one of the early roentgenographic signs of inflammatory diseases of the hip. The authors are not aware of any systematic investigation as to its meaning and diagnostic importance. A rather extensive search of the American literature of the last ten years did not reveal any appreciation of the value of this sign in the early diagnosis of hip disease. Hepler's article deals with a very late stage with abscess and involucrum, while the paper of Freiberg and Perlman mentions an intra-



FIG. 3-A
W. L. Normal obturator shadows.

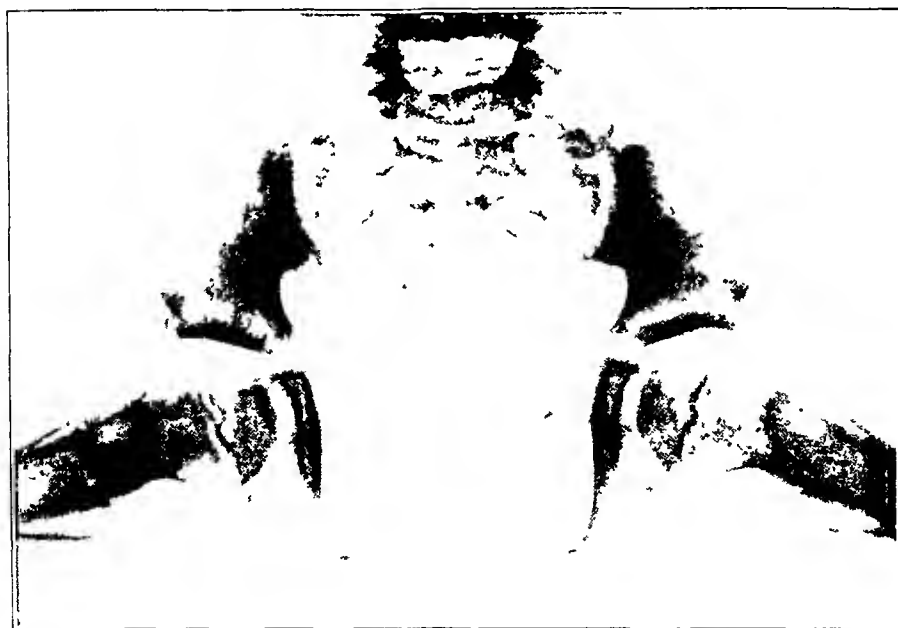


FIG 3-B
Normal obturator shadows with patient in "frog position".

pelvic soft-tissue shadow which they thought was due to a frank iliac abscess.

ANATOMY

Four structures were considered as possibly involved in the production of this shadow: (1) iliopsoas, (2) intrapelvic lymphatics, (3) capsule of the hip joint, (4) obturator internus.

It is felt that the iliopsoas has been ruled out as the involved structure. Dissection was carried out on a postmortem specimen, so that the fibers of the psoas and iliacus were laid bare. A curved wire was then placed along the inner border of the psoas and an anteroposterior roentgenogram showed that the psoas did not correspond to the shadow described. The psoas was then removed and another roentgenogram was obtained. This showed no change in the shadow. Figure 2 shows a well-defined calcified psoas abscess overlying a normal shadow.

The possibility of lymphadenopathy along the intrapelvic vein being the cause of the shadow was ruled out when ten consecutive cases of infection in the soft tissue about the thigh with inguinal lymphadenopathy showed no change in the shadow.

The position of the lymphatics does not correspond to the position of the shadow as seen in the roentgenogram.

The last possibility is the obturator internus muscle, and the



FIG. 4

J. D. L. March 2, 1940. Septic arthritis of the left hip two weeks after the onset of symptoms. There is slight haziness of the head of the left femur. The border of the obturator shadow is obscure, but can be faintly seen to extend to the edge of the pelvis. The obturator sign is 4 plus.

authors believe this has been definitely proved to be the substratum of the shadow. The fibers of the obturator internus were laid bare in a post-mortem specimen, and a wire was placed along its medial border. This corresponded exactly to the position of the border of the shadow as seen in all the roentgenograms.

PATHOLOGY

The authors have not had an opportunity to determine the intrapelvic pathological changes occurring in cases of septic arthritis of the hip with changes in the obturator internus demonstrable roentgenographically, because no autopsy on such a case has been available.

However, it will be remembered that the tendon of the obturator passes immediately adjacent to the capsule of the hip, and that extension of the inflammatory process may well lead to a roentgenographically visible swelling of the obturator muscle. In far-advanced cases this may represent a true abscess formation; in early cases, only oedema of the muscle. It seems probable that other muscles in close proximity to the hip joint are also involved. This, however, cannot be shown on roentgenograms because of overlying structures. There is no other muscle about the hip which may be roentgenographically differentiated from surrounding soft tissue.

DESCRIPTION OF SIGN

The obturator sign consists in a widening and a change in the contour of the normal obturator shadow as above described. This widening may be from slight to very marked and four gradations, from 1 to 4, have been made more or less arbitrarily. Grade 2 was considered to include those cases in which the shadow was approximately twice the normal width; Grade 4, more than four times the normal; and Grades 1 and 3 were placed correspondingly. In most instances the opposite hip may be taken as the normal.

In a very small number of cases it was noted that the obturator shadow was obscured. It was impossible to determine the border of the shadow because of haziness. After making the study the conclusion was reached that an obscured obturator shadow is a positive finding indicative of hip-joint pathology.

It is believed that the widening, the changes in contour, and the obscurity of the border, may be compared with the well-known changes of the psoas shadow, seen in roentgenographic examination of a psoas abscess, perinephritic abscess, or other inflammatory process overlying, or in contact with, the psoas muscle.

TECHNICAL CONSIDERATIONS

The usual technique for routine anteroposterior roentgenograms of the pelvis is followed. No special advantage has been shown by using

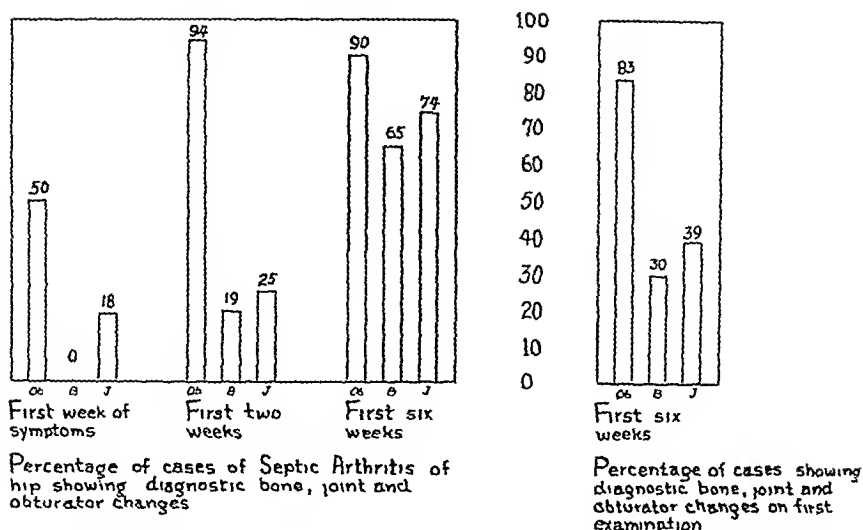


FIG 5

Note that those seen during the first two weeks include six patients seen during the first week.

soft-tissue technique. Care must be taken that the pelvis is level or one obturator may be thrown into higher relief than the other one.

In some cases it has been advantageous to obtain an anteroposterior view of the pelvis with the hips in marked abduction, flexion to 90 degrees, and marked external rotation (so-called "frog position", frequently used in obtaining lateral views of the hips) which seems to bring the obturator shadow into greater relief.

In a fair number of cases it is found impossible to obtain this position

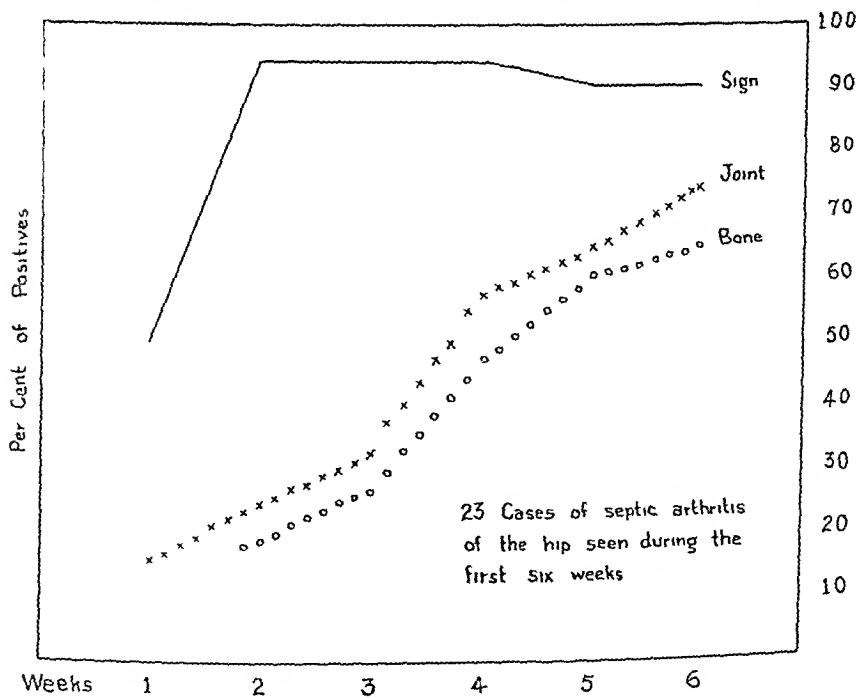


FIG. 6

because of pain and muscle spasm. In all cases it is obligatory that both hips be in the same position if one is to have a basis for comparison.

CLINICAL APPLICATIONS

Septic Arthritis of the Hip

Twenty-three cases of suppurative arthritis of the hip served as the clinical basis for this study. These cases were broken down into groups depending upon the duration of hip symptoms prior to roentgenographic examination, in order that the value of the obturator sign in early hip pathology might be determined. All cases were proved by bacteriological examination, by surgery, or by the clinical course—such as subsequent ankylosis, sequestrum formation, etc.

Six patients were examined by roentgenogram during the first week after the onset of symptoms. Of them, three, or 50 per cent., showed a positive sign; one was classified as Grade 2; and two as Grade 1. None had bone changes; one, or 18 per cent., had joint changes (Fig. 5).

Sixteen patients, including the six seen during the first week, were examined roentgenographically during the first two weeks after the onset of symptoms. All but one of these showed a positive obturator sign. This particular patient died on the ninth day after onset, and it may well be that the overwhelming sepsis became severe enough to cause death before the local conditions could produce the sign. In two cases, the shadow was obscured; in three cases the shadow was classified as Grade 1; in



FIG. 7

E. E. September 26, 1940. Septic arthritis, left hip (*staphylococcus aureus*). The obturator sign is 2 plus. The first roentgenogram, which was taken three days after onset of symptoms, showed a 1 plus obturator sign, but no bone or joint pathology.

seven cases, as Grade 2; in one case, as Grade 3; in two cases, as Grade 4. Therefore, 94 per cent. of these sixteen cases showed positive changes



FIG. 8

G. F. May 20, 1941. Septic arthritis of the right hip, eight days after onset of symptoms. No bone or joint change is visible, but the obturator sign is 2 plus. Traction was applied and the patient was given sulfathiazole. He became clinically cured. No bone or joint pathology has yet been observed. The obturator sign became 1 plus.



FIG. 9

E. B. January 9, 1931. Septic arthritis of left hip, three weeks after the onset of symptoms. The obturator sign was 2 plus. It was another two weeks before any bone or joint change was observed.

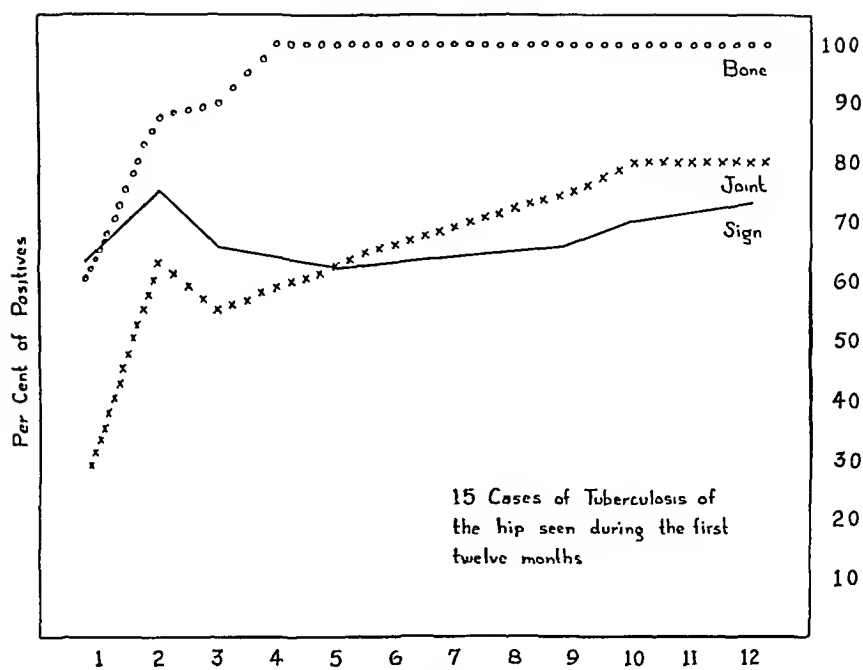


FIG. 10

in the obturator shadow; 19 per cent. showed bone changes; and 25 per cent. showed joint changes (Fig. 5).

Seven additional patients were first examined roentgenographically after the first two weeks of symptoms but before the end of six weeks. All but one of these showed a positive sign. The first roentgenogram of this patient at this Hospital was taken five weeks after the onset of symptoms and one week after surgical incision and drainage of the hip had been done. It has been noted that after incision and drainage, or after the local disease has become quiescent, the sign may become less positive or even negative. Many patients, however, show changes of Grade 2 or 3 for the entire period that they have been followed, which in some instances was more than five years.

Taking into consideration all twenty-three cases seen within a period of six weeks after the onset of symptoms, twenty-one, or 91 per cent., showed a positive obturator sign. The probable reasons for the two negative results were, in one, incision and drainage, and in the other, death by overwhelming sepsis before the sign could become positive.

Bone changes were seen in 65 per cent. before the end of six weeks. Joint changes were seen in 74 per cent. of the cases. There were four patients with positive obturator signs, who, however, showed no bone or joint changes at the end of six weeks. Of these, one was observed for only seventeen days and another for four weeks; both may later have developed bone and joint changes. Two showed joint changes after six weeks.

In fourteen cases the invading organism was determined. Of

these, two were pneumococci, three were hemolytic streptococci, one was staphylococcus albus, and the remaining eight were staphylococcus aureus.

This study showed no appreciable difference in the frequency or time



FIG. 11-A

V. L. July 13, 1940. Tuberculosis of the left hip. Onset of pain occurred about June 24, 1940, and limp was first noted about June 31, 1940. This first roentgenogram shows no bone or joint change although the obturator sign is 2 plus. Mantoux test was 4 plus, and the sedimentation rate was very rapid.



FIG. 11-B

V. L. August 12, 1940. Early bone changes are visible just above the ilio-ischial junction. The obturator sign remains 2 plus.



FIG. 11-C

V. L. March 31, 1941. After surgery the area of destruction continued to enlarge. On February 29, 1941, an extraeapsular incision and drainage of the bone abscess were done, and a guinea pig was inoculated. It was reported positive for tuberculosis on April 11, 1941.

of appearance of bone, joint, or obturator-shadow changes for the various infecting organisms.

The obturator sign is of greatest value during the early weeks of hip disease. At the end of the first two weeks it was possible to make a roentgen-ray diagnosis of hip disease in 94 per cent. of the cases, whereas using bone and joint changes alone, the diagnosis could have been made in only 25 per cent. (Fig. 6). The curve for percentage of cases having a positive obturator sign rises sharply from 50 per cent. at the end of the first week to over 90 per cent. The curve was not followed after six weeks.

The curves for percentages of cases with bone and joint changes rise much more slowly, and even at the end of a six-week period do not approach the height of the percentage curve for the obturator sign. The joint changes are considerably more frequent than bone changes.

The obturator sign was first found positive on the third day; joint changes on the fifth; and bone changes on the eighth.

The obturator sign in septic arthritis of the hip is not peculiar to children, but has been observed in adults, although such cases were not included in this study.

Tuberculosis

The onset of tuberculosis of the hip is so much less sudden and dramatic than septic arthritis, that the first roentgenographic examination is

usually made weeks or even months, rather than days, after the onset of symptoms.

The authors' material consisted of seventeen cases of hip tuberculosis, fifteen of which were seen during the first twelve months.

These cases were again divided into two groups, depending upon the duration of symptoms.

The first group consisted of eight patients seen within the first three months. Of these 90 per cent. showed bone changes, 66 per cent. showed obturator changes, and 55 per cent. showed joint changes.

Fifteen patients were observed during the first twelve months, and of these 100 per cent. showed changes in the bones of the hip joint, 80 per cent. showed joint changes, and 73 per cent. showed obturator changes. Eighty-seven per cent. showed bone changes at the first examination, 66 per cent. joint changes, and 73 per cent. obturator changes.

Of the seventeen cases observed during the first twenty-four months 100 per cent. showed bone changes, 88 per cent. joint changes, and 76 per cent. obturator changes.

It was noted that in tuberculosis of the hip, the obturator shadow was most frequently obscured, rather than showing a distinct bulging with sharply demarcated border, as is usually seen in septic arthritis. This may be compared to the loss of visibility of the psoas shadow in the roentgenogram in tuberculosis of the spine. The obscured obturator shadow in hip tuberculosis is a positive finding.

It is obvious that the obturator sign is of no great value in making a diagnosis of early tuberculosis of the hip, inasmuch as both the bone and joint changes usually appear earlier and with greater frequency. However, in one of the authors' cases (Figs. 11-A, 11-B, and 11-C), the obturator sign was of value. In this case it became positive four weeks before either bone or joint change. It may be that if roentgenograms were available very early in tuberculosis of the hip joint, the obturator sign might prove to be of more importance than shown in these cases.

It is to be noted that in this small series, bone changes appeared earlier and with greater frequency than joint changes. This is contrary to the generally accepted view that joint change is the first sign of hip tuberculosis.

Other Pathological Conditions of the Hip Studied

1. *Perthes' Disease.* The roentgenograms of twenty cases of Perthes' disease in all stages, early and late, were reviewed, and in no instance was any change in the obturator shadow noted.

2. *Epiphysiolysis (Slipping of the Capital Epiphysis).* Seven cases of epiphysiolysis of varying degree were observed with a normal obturator sign.

3. *Rheumatic Fever with Clinical Involvement of the Hip.* Six cases of rheumatic fever with clinical involvement of the hip were studied, and the obturator shadow was normal throughout.

4. *Fracture about the Hip.* In ten cases of fracture of the pelvis, ischium, ilium, and femur close to the hip joint, no pathological change in the obturator outline was evident.

5. *Osteomyelitis of the Pelvis Not Involving or Neighboring the Hip Joint.* Six cases of this type were studied, and again no obturator involvement was noted.

6. *Soft-Tissue Infection about the Thigh with Marked Inguinal Lymphadenopathy.* Ten such cases presented an entirely normal appearance of the obturator shadow.

SUMMARY

1. The normal appearance of the obturator shadow is described.
2. In certain types of hip pathology the obturator shadow becomes obscured, or it becomes widened with a more curved border. This is called a positive obturator sign.
3. The greatest value of this sign is in the early roentgenographic diagnosis of septic hip disease.
4. It is of some importance in the early diagnosis of tuberculosis of the hip.
5. It is not present in fractures about the hip, osteochondritis, and other pathological conditions of the hip.

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ELONGATION OF THE HEEL FOR CALCANEUS DEFORMITY

BY HENRY MILCH, M.D., NEW YORK, N. Y.

Astragalectomy, advocated by Whitman, has become established as a standard procedure in the treatment of paralytic pes calcaneovalgus. From the point of view of the physiology of the foot, this procedure accomplishes two separate purposes: (1) It eliminates the subastragalar joint in which the valgus deformity develops; and (2) it tends to equalize the length of the hind foot relative to the forefoot, and so compensates for the muscle imbalance which causes the calcaneus. The latter objective, achieved by displacing the foot backward under the axis of rotation at the ankle joint, serves to shorten the anterior lever arm upon which the dorsal extensors act, and to lengthen the posterior lever arm upon which the plantar flexors act. Since the work accomplished by a muscle group is equivalent to its muscle force multiplied by the length of the lever arm through which it is applied, the increased distance of the Achilles tendon from its axis of rotation tends to magnify its effective power, and so to restore the distorted muscle balance between the flexors and extensors of the foot.

Though the success of astragalectomy in cases of complete paralysis is a tribute to the genius of Royal Whitman, it may appear somewhat radical in milder cases of paresis of the Achilles tendon. In such event it seemed reasonable to hope that the actual elongation of the os calcis might serve to lengthen the lever arm, and so restore balance without sacrificing the subastragalar joint. The satisfactory result obtained in the following case prompts its report.

Walter K., aged four, was first seen in April 1935. Born at full term, after a difficult delivery, the child apparently suffered a cerebral insult with a consequent mild right spastic hemiplegia. It was noticed when the child began to walk, that the heel could not be brought to the floor. Physiotherapy and stretching of the Achilles tendon had been attempted at another hospital, but this gave only slight improvement, and a marked contracture was still present upon admission to the Hospital for Joint Diseases.

On May 23, 1935, a Z-shaped lengthening of the right Achilles tendon was performed, and the leg was encased in plaster. On July 3 the plaster was removed. The wound had healed *per primam*. There was active power of flexion and extension at the ankle joint. Physiotherapy was instituted, and the patient was permitted to begin walking. Toward the end of July 1935, the child showed a definite tendency toward a calcaneus type of gait. To overcome this the heel was elevated, and for a time it was hoped that this might suffice. By November it was decided that this hope was futile, and more radical treatment came under consideration.

It was apparent that, as a result of the Achilles lengthening, the plantar flexors had been weakened and the muscle balance disturbed in favor of the dorsal extensors of the foot. Correction by shortening of the Achilles tendon seemed to be indicated. However it seemed desirable to test the validity of a different concept,—that of magnifying the strength

of the existing Achilles musculature by increasing the length of the lever arm through which its force was applied.

With this object the patient was operated upon on November 21, 1935. A curved incision, three inches long, was made along the outer aspect of the Achilles tendon, and around the lower end of the fibula. The Achilles tendon was exposed, and was followed down to its attachment into the os calcis. The upper surface of the calcaneus was exposed, and a large osteotome was driven through the posterior end of the bone, parallel to the attachment of the Achilles tendon. The posterior portion was then turned down, opening up a V-shaped wedge in the tuberosity of the os calcis. This space was filled



FIG. 1

January 20, 1936. Roentgenogram taken after operation. The site of the osteotomy of the os calcis may be seen. The distance from the axis of motion in the ankle joint to the attachment of the Achilles tendon has been increased.



FIG. 2

October 26, 1940. The site of the earlier osteotomy may still be recognized. The proportions of the os calcis are relatively normal, but the epiphysis of the os calcis is on the *postero-inferior*, instead of on the posterior aspect of the os calcis.

with fragments of bone removed from the tibia. As a consequence of this, the posterior projection of the os calcis and the distance of the Achilles tendon from its center of rotation at the ankle joint were increased. The insertion of the Achilles tendon was thus displaced downward, so that it pointed plantarward, instead of backward. Some difficulty was experienced in closing the skin wound, because of the increase in the length of the os calcis. A plaster-of-Paris boot was applied, with the foot in slight equinus and the knee at right angles. Three days later the patient was discharged to the Out-Patient Department.

On January 8, 1936, the plaster was removed, the wound was found healed, and physiotherapy was begun. In May 1936, marked improvement in the patient's gait was noted. Reexamination in June 1941 disclosed apparently normal proportions of the heel. The motions of the foot were excellent, and the patient manifested good power in the Achilles tendon when walking or running. There was no evidence of either an equinus or a calcaneus deformity of the heel, but there appeared to be a mild cavus, due to the dropping of the forefoot.

The restoration of balance obtained seemed to be due mainly to the increased length of the posterior lever arm to which the *Achilles tendon* was attached. In the author's own mind, it seemed to stress the fact that the work done by a muscle group may be influenced, either by modifying the length of the muscle itself, or by altering the length of the lever arm upon which the intrinsic muscle power is applied. It suggested another method of reestablishing muscle balance in certain cases of mild flaccid paralysis, where the possibility of modifying the intrinsic power of the muscles is precluded.

CALCIFICATION AND OSSIFICATION OF THE MENISCI *

BY JAMES B. WEAVER, M.D., KANSAS CITY, MISSOURI

From the University of Kansas Hospitals, Kansas City, Kansas

CALCIFICATION

Calcification of the menisci of the knee joint has received scant attention in the American literature. The author wishes, therefore, to record the following two cases.

CASE 1. A man, forty-seven years of age, was admitted to the Hospital, suffering from a severe attack of asthma of eight weeks' duration. Orthopaedic consultation was requested because of pain and oedema of the right knee and ankle.

The patient's first asthmatic attack had occurred two years previously, and he had been treated in another hospital for six weeks. During that time he had had pain and oedema of the right knee, which cleared up quite promptly under diathermy and infra-red-heat treatments. In the two-year interim he had had only mild asthmatic symptoms and no particular trouble with the knee. The patient stated that during childhood he had run a hedge thorn into the right knee. The thorn was said not to have been recovered and roentgenograms taken at the age of thirty-five years were said to have shown that the thorn had "turned to stone". The presence of the thorn, according to the patient, had always caused weakness of the knee.

Examination showed marked hydrops of the right knee. There was some increased heat, but the knee was not very tender. Redness, swelling, and increased heat were noted about the ankle, which was moderately tender. About 200 cubic centimeters of straw-colored fluid was aspirated from the knee joint. This fluid was sterile for bacterial growth.

Roentgenograms of the right knee (Fig. 1-A) showed calcification of both menisci. The left knee and both ankles were thereafter x-rayed. Both menisci of the left knee, in which no symptoms had ever been present, were seen to be also calcified (Fig. 1-B). The roentgenograms of the ankles were negative for abnormalities.

Diathermy treatments were instituted, and in ten days there was complete relief of symptoms. There had been no recurrence when he was discharged from the Hospital two weeks later. The subsequent course is not known.

CASE 2. † A man, fifty-five years of age, was admitted to the Hospital because of arthritis of multiple joints of several years' standing. He had pain in the shoulders, back, knees, feet, and ankles. Roentgenographic examination of these parts showed hypertrophic changes. Calcified menisci were apparent in the roentgenograms of the knees (Figs. 2-A and 2-B), and the lumbar intervertebral discs were also calcified.

In addition to these two cases, reports of seventy-six others have been found in the literature, making a total of seventy-eight reported cases (Table I). A case report by Beiler was found to have been previously reported by W. Schwarz and is not included in this series.

In addition to the seventy-eight cases in Table I, Mandl, in the histological examination of menisci from thirty-eight patients who had been operated upon, found fourteen cases of calcification not due to trauma.

* Read at the Annual Meeting of The American Academy of Orthopaedic Surgeons, Atlantic City, New Jersey, January 13, 1942.

† From the U. S. Veterans Administration Hospital, Wadsworth, Kansas, through the courtesy of C. B. Francisco, M.D.

Tobler examined the menisci taken at autopsy in 1000 cases of calcification in 400 cases, and found histological evidence of calcium in older individuals. Bircher found three cases of calcification in which he made microscopic examinations. Wolke, Muller, Wagner, and Eck examined a total of 12,268 roentgenograms of knees and found that fifty-two, or 0.42 per cent., showed calcium in the menisci. From the foregoing evidence it would seem that calcification of sen-



FIG. 1-A
Case 1. Right knee



FIG 1-B
Case 1. Left knee

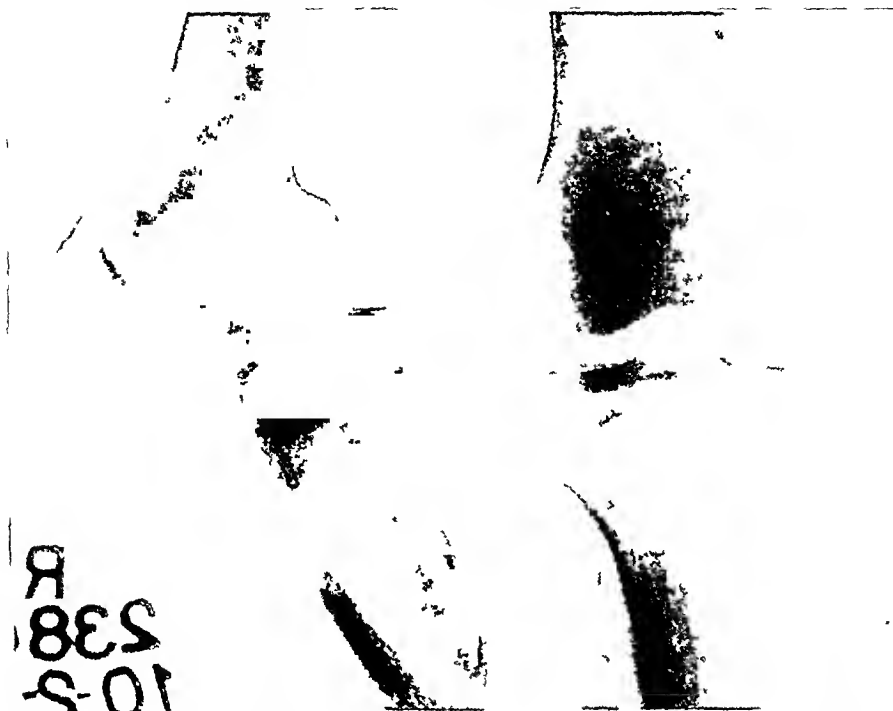


FIG 2-A
Case 2 Right knee

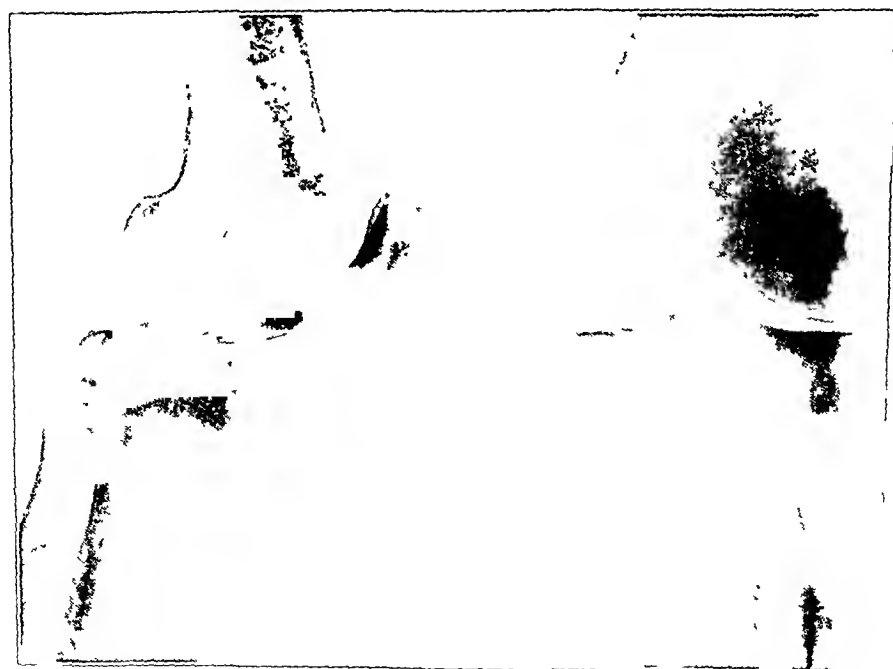


FIG 2-B
Case 2, Left knee

TABLE I
CALCIFICATION OF THE MENISCI

Author	Year	Primary (Non-Traumatic) <i>No. of Cases</i>	Secondary (Traumatic) <i>No. of Cases</i>
Andreesen	1933	4	9
Backmund	1933	1	0
Balensweig and Bosworth	1937	2	0
Bruchholz	1929	1	0
Eck	1939	0	15*
Fabbro	1939	3	2
Frund	1926	0	1
Henrichsen	1932	0	1
Hilgenreiner	1932	0	1
Israelski and Pollack	1930	3	0
Massabauau, Guibal, Joyeux, et Rodier	1939	0	1
Meyer-Boistel	1931	1	0
Muller	1933	2	0
Paltrineri	1937	1	0
Rubaschow	1929	0	1
Schapiro	1931	0	1
Schwartz, E	1930	1	0
Schwarz, W	1932	1	0
Sommer	1929	1	1
Sonntag	1928	1	0
Wagner	1933	10	2
Weaver	1942	2	0
Werwath	1928	1	0
Wolke	1935	8	0
Total		43	35

* Eck reported 16 cases. The author has listed one of these cases as secondary ossification, as the affected cartilage contained bone, and was very similar to the author's Case 3.

cartilages (menisci), while not a common finding, can hardly be classified as a rarity.

Primary and secondary calcification in menisci are two separate and distinct entities that have little in common except the presence of calcium. Mandl was the first to differentiate between a primary, or non-traumatic, and a secondary, or traumatic, type of calcification. Frund, in 1926, was the first to publish a roentgenogram showing the secondary type, the presence of which he had verified at operation. In 1928, Werwath published the first roentgenogram of the primary type with a report of operative verification, although Mandl had previously described the histological picture of such menisci.

The following observations on these two types are based on the data furnished by the authors listed in Table I.

Incidence: The ratio of forty-three primary to thirty-five secondary

cases (Table I) is considered to be not a true picture. Many case histories were very scanty, and the author feels that some cases listed as secondary were, as a matter of fact, primary. If the cases of Mandl, Tobler, and Bircher had been included in the primary list, the ratio would be much greater. Then, too, many patients with primary calcification have no complaints and, therefore, their cases are not deemed of sufficient interest for publication. The opposite is true of the secondary type.

Age: The primary type occurs in older individuals. The youngest patient whose case was reported was thirty-two years of age, and he was the only one under forty years of age. Four were under fifty years and the remainder were over fifty years of age, many being over seventy years. The secondary type occurs in younger individuals. Fully 80 per cent. of the patients were in the third decade of life. The youngest was eighteen years of age.

Sex: There was a preponderance of males in both types.

Cartilage Affected: Both menisci of both knees were affected in cases of the primary type, but only one meniscus in each knee was affected in cases of the secondary type.

Deposition of Calcium: In the primary cases, the calcium is laid down in parallel layers, starting at the periphery of the cartilage and involving the entire length. The meniscus is smooth. The secondary cases show a localized zone of calcification, usually in one end or the other, and of the central type. This calcium piles up, causing a roughening and enlargement of the part of the cartilage affected.

Roentgenographic Appearance: The primary type shows a waferlike aspect of the cartilage in the anteroposterior view and wedge-shaped shadows at each end of the meniscus in the lateral view. This suggests a diffuse calcification of all four menisci, although these areas may vary in size and density according to the age of the lesion. Calcification may be revealed in individual menisci at various times in the same patient. The roentgenographic appearance is characteristic and diagnostic. The secondary type shows a localized piling up of calcium, rough in outline, which might be confused with a joint mouse or ossification in the cartilage. The picture is not diagnostic.

Symptoms: In many instances primary calcification produces no symptoms. Some cases were discovered by accident. Many patients had symptoms in one knee only, but had calcified menisci in both knees, as in Case 1. In some cases complaints were severe enough to necessitate the removal of the cartilage. Symptoms were pain, swelling, limitation of motion, and, at times, hydrops. Pain, swelling, and limitation of motion were the principal symptoms of the secondary type. These quite universally progressed to such severity that removal of the cartilage was necessary.

Complications: Hypertrophic arthritis, both in the affected joints and in other joints, was almost a constant finding in the primary cases. Calcification of intervertebral discs, as well as calcification of other struc-



FIG. 3-A

Case 3. Right knee, before operation.

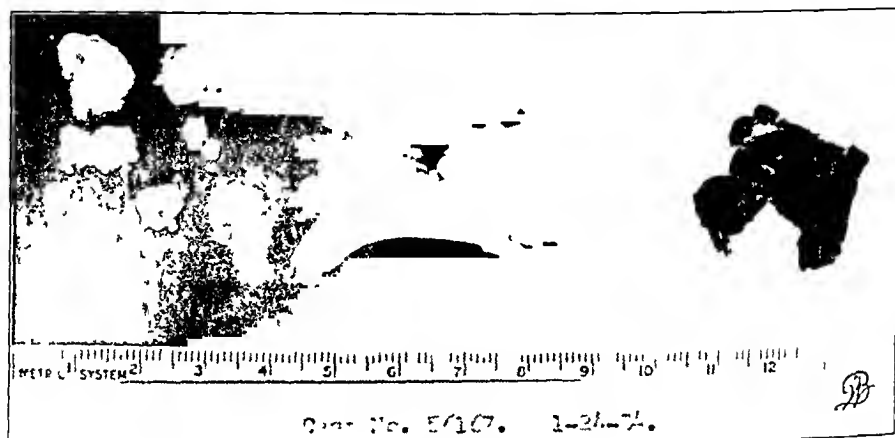


FIG 3-B

Case 3. Photograph of the pathological specimen.

tures, was a frequent finding. Wolke described plaques of calcium in the articular cartilages in some of his patients. Diabetes, chronic nephritis, gout, asthma, *et cetera*, were also reported as complications, but their significance is questionable. No particular complications were noted in the secondary type, although joint mice were found in four instances.

Etiology: The etiology of primary calcification is unknown, but the condition is considered to be the result of nutritional deficiency due to advanced age. The secondary type is, of course, thought to be the result of trauma. This trauma was severe in all instances, and was caused either by a direct blow or by twisting. Andreessen reported six cases of luxation of the internal semilunar cartilage, all of which showed calcifica-

tion in the detached portion of the meniscus. In eleven of Eck's cases partial or complete luxation of the medial meniscus was present.

Treatment: In the primary type, the treatment is symptomatic. Excision of cartilage is infrequently necessary. Spontaneous cures were numerous. Extirpation is always necessary in the secondary type.

OSSIFICATION

Ossification of the semilunar cartilage is a condition closely allied to calcification of the cartilage and may be a sequela to calcification. The author reported the following case in 1935.

CASE 3. A male, aged twenty-four years, while riding a horse, sustained an injury to the right knee, when it was jammed against a fence. Thereafter, the patient complained of progressive pain, oedema, and limitation of motion, which finally incapacitated him. Roentgenographic examination (Fig. 3-A) revealed calcareous deposits. The affected cartilage was removed twenty months after the injury. Histological examination showed in one portion calcified areas associated with beginning bone formation. In other areas there was cartilaginous tissue in which secondary calcification was occurring and in which bone formation could be recognized. (See Figure 3-C.)

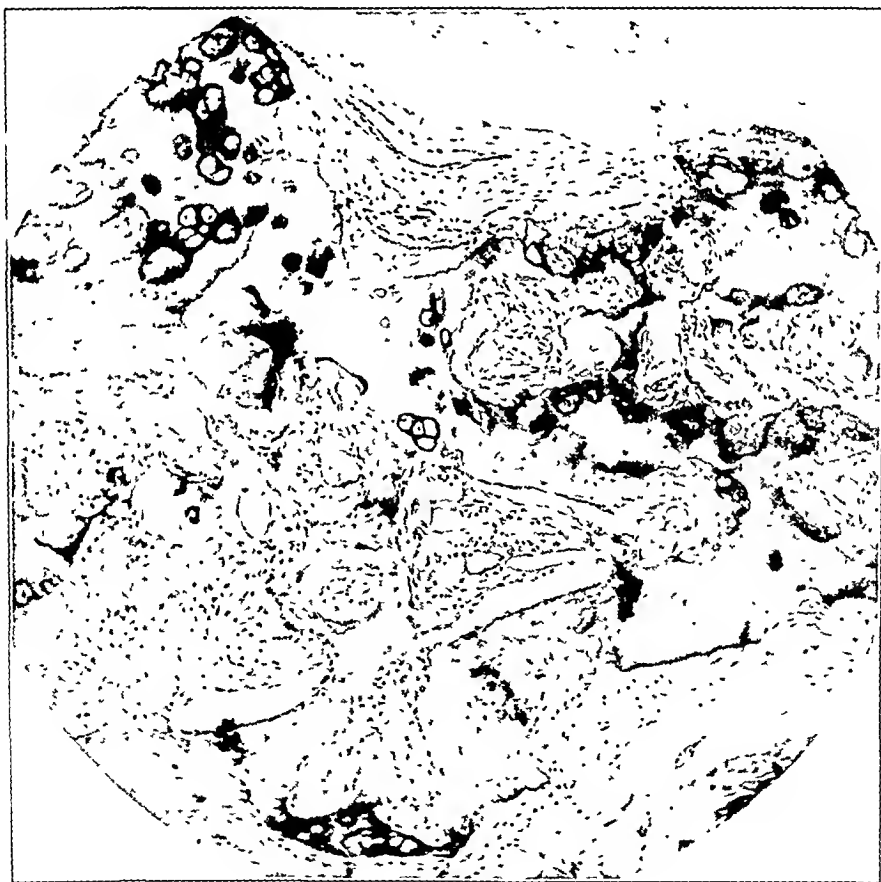


FIG. 3-C

Case 3. Photomicrograph showing new bone and calcium in the meniscus.

Reports of other cases of ossification found in the literature are listed in Table II. Wollenberg was apparently the first to describe this condition. Most of these cases were secondary or traumatic in nature. The primary cases listed are of interest, but are considered to be of minor importance.

The symptoms, roentgenographic appearance, and treatment of secondary ossification of semilunar cartilages are practically the same as in secondary calcification. The question therefore arises as to whether secondary calcification is a precursor of secondary ossification. Certainly no evidence was found that primary calcification is a precursor of ossification. Harris, from anatomical studies, deduced that calcium might form on the surface of semilunar cartilage due to senile changes (primary), but both calcium and bone could form in the central portions, provided a zone of mucoid, fatty, or hyaline degeneration was present (secondary). Calcium, as well as bone, was found in the cases reported by Wollenberg, Eck, and Weaver, but not in the other secondary cases reported in Table II. It seems quite certain that secondary calcification does progress to ossification, but apparently does so in only a small percentage of the cases. Whether or not, in the cases of ossification with no calcium present, there had been calcium at an earlier date is problematical. Watson-Jones and Roberts, and Burrows thought it probable that calcium had been present in their cases, and that they were dealing with a true example of heterotopic bone formation according to the theory of Leriche and Polkard. The main steps in this theory are:

1. Formation of the ossifiable medium. This is brought about by the degeneration of the connective tissue to an embryonic state due to traumatic or infectious inflammation.

2. Calcium deposition and its resorption. All heterotopic ossification takes place in the vicinity of a calcified deposit at the point of phosphocalcific concentration.

3. Formation of heterotopic ossification. When an embryonic con-

TABLE II
OSSIFICATION OF THE MENISCI

Author	Year	Primary (Non-Traumatic) No of Cases	Secondary (Traumatic) No of Cases
Burrows	1934	0	2
Eck	1939	0	1
Giraudi e Carnevali	1933	1	0
Tobler	1933	1	1
Watson-Jones and Roberts	1934	0	2
Weaver	1935	0	1
Wollenberg	1931	0	1
Total		2	8

nective tissue which has become ossifiable and a collection of calcium are brought together by chance, ossification takes place by the usual processes.

The cases of secondary ossification reported by Wollenberg, Eck, and Weaver are unquestionably true examples of heterotopic bone formation, and the other cases are probably in the same category. The author is of the opinion that many cases of secondary calcification do not progress to ossification, and that those of primary calcification very rarely, if ever, do.

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ARTHRODESIS OF THE WRIST WITH THE USE OF GRAFTS OF CANCELLOUS BONE *†

BY LEROY C. ABBOTT, M.D., JOHN B. DEC. M. SAUNDERS, M.B., F.R.C.S.,
AND FREDERIC C. BOST, M.D., SAN FRANCISCO, CALIFORNIA

From the Division of Orthopaedic Surgery, Department of Surgery, and the Department of Anatomy, University of California Medical School, San Francisco

For the improvement of function in disabilities which occur in the upper extremity, one of the most valuable procedures is arthrodesis of the wrist. In postpoliomyelitic paralysis of the hand and forearm, the operation is comparable in value with stabilization of the foot when the lower extremity is involved. It can also be employed with great benefit in paralysis of the spastic type and in Erb's palsy, or when permanent damage has occurred either to the brachial plexus or to the peripheral nerves of the arm. Furthermore, it is effective in the treatment of painful wrists due to arthritis of either traumatic or infectious origin. This important procedure, therefore, demands a method of operation which will ensure certain and rapid fusion of the joint. Such a method, with the use of cancellous bone as a grafting material, has been employed by the writers for more than twenty years. The technique is simple and yields eminently satisfactory results.

A careful review of the literature shows that a wide variety of methods have been described for stabilization of the wrist, among which, in early works, is the bizarre use of heteroplastic bone grafts from the dog (Dubar, 1897). Steindler described the open-wedge operation in 1918 and reported the results of twenty-five cases in 1921. In 1920, Ely presented his technique with the use of a tibial graft in cases of tuberculosis of the wrist. Scherb (1927) used a graft from the upper end of the femur which, because of its concavity, could be fitted to the surfaces of the wrist joint. Liebolt (1938) reported forty-four cases. He considered small bone chips better than large bone grafts, because the former revitalized more quickly than the latter. Bone chips were obtained from different parts of the skeleton, usually from the distal end of the radius. Cartilage was removed from each carpal bone to be fused and portions of these bones were broken down into chips. When these sources were insufficient, the ilium or tibia was used. Liebolt believed that the ideal position for function of the ankylosed wrist was 25 to 30 degrees of extension and the neutral lateral position.

In 1940, Smith-Petersen reported a method for arthrodesis of the wrist, and described a new approach to the wrist joint. The incision

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started two or two and one-half inches above the ulnar styloid, ran parallel with the ulna to a point just distal to the styloid, and then curved anteriorly in the direction of the proximal end of the fifth metacarpal. The distal portion ran parallel with this bone for a distance of approximately one inch. A bayonet incision of this type resulted in two flaps which were easily retracted.

The ulnar periosteum was exposed and incised. Following an oblique osteotomy, the distal inch or so of the ulna was removed, exposing the ulnar aspect of the radius. The capsule and ligaments were reflected from the radius along with the periosteum of the latter, exposing the radiocarpal joint. The same procedure was carried out distally, reflecting capsule and ligaments from the carpus. With the hand in the position of dorsiflexion, slots were cut in the radius and the carpus, into which the graft was sunk. As a rule, the excised portion of the ulna, properly shaped, made an efficient graft; the remaining fragments were packed around its volar aspect.

As far as can be determined from this review, no method has been described which is similar to the one herein reported.

SURGICAL AND FUNCTIONAL ANATOMY OF THE WRIST

From the functional point of view it should be borne in mind that it is the unity of interrelated action of the several joints of the upper extremity, which gives to the hand and wrist its synchronized grace and ease of movement. It is therefore necessary for the surgeon to consider for a moment the extent of this characteristic before applying procedures which will disrupt the close association of joints, if he is to preserve the maximum function commensurate with his therapeutic aim.

The region of the wrist is a complex of several joints, the function of which is to give to the hand its great range and versatility of action. The complex consists of the radio-ulnar, the radiocarpal, the several intercarpal, the transverse intercarpal, the carpometacarpal, and intermetacarpal joints.

As is well known, the distal, together with the proximal, radio-ulnar joints primarily provide a mechanism which permits the movements of pronation and supination about the longitudinal axis of the ulna. It is commonly, but incorrectly, taught that the center of rotation in these movements lies at the base of the ulna styloid, corresponding to the point of attachment of the triangular articular disc. It can be demonstrated, however, that this is not the case, but that the center of rotation passes through the center of the head of the ulna. This fact indicates that the ulna is not absolutely fixed during these motions, but that some antero-posterior movement of its head is permitted.

Besides the movements of rotation, the authors have been able to demonstrate an important upward and downward, or pistonlike, movement of the radius on the ulna. This movement is the mechanism which ensures the maintenance of the relation of the radius to the ulna at the

wrist joint during movements of rotation of the forearm, and on flexion and extension of the elbow. This piston movement is a necessary one, allowing for adjustments between the radius and the ulna, because of the pathway, convex to the ulnar side, through which the forearm passes from extension to flexion. Without it the radius would become relatively too short with each movement of flexion at the elbow. Morphological provisions for the piston movement are seen in the extension of the articular surface of the proximal end of the radius onto the ulnar side of its neck, in a similar extension of the articular surface on the radial side of the head of the ulna, and in the forward projection of the capitellum of the humerus. The not infrequent clinical finding of pain and weakness at the wrist following injuries to the lower humerus is no doubt due to a derangement of this piston movement which, by upsetting the relationship of the ulna and the radius at their distal extremities, impedes the smooth action of the wrist. Such a derangement emphasizes the importance of maintaining, as far as possible, the forward position of the distal articular surfaces after intracondylar and supracondylar fractures of the humerus.

In addition, it should be pointed out, with respect to the radio-ulnar joints, that at a point approximately half-way between pronation and supination, the articular surfaces are in greatest congruence, and establish a virtual synarthrosis between the bones, thus defining this as the position of greatest stability.

The movements at the wrist itself occur at the radiocarpal and intercarpal joints and the compound joint between the proximal and distal row of carpal bones, which is termed for convenience the transverse intercarpal joint. There is a tendency to look upon the wrist joint as a simple hinge allowing flexion and extension, and permitting radial and ulnar deviation of the hand. In point of fact, however, the movements are exceedingly complex, and only a brief summary of the main points will be given here.

Flexion, from the mid-position at the wrist, occurs mainly at both the wrist joint proper (radiocarpal joint) and the transverse intercarpal. The greater part of this movement takes place at the transverse intercarpal joint, and, in consequence, intercarpal lesions lead to greater disability in flexion than do those at the wrist joint proper. In this movement the navicular (scaphoid) shows a wide range of movement in relation to other bones of the proximal row.

Extension of the wrist is likewise compounded of radiocarpal and transverse intercarpal movements, but, in contrast to flexion, the greater range occurs at the radiocarpal. In addition, it is during this movement, as pointed out by MacConaill, that an elaborate screwing or locking mechanism comes into play which stabilizes the wrist.

In the total range of flexion-extension, it is surprising to find that slightly more than half of the movement occurs at the transverse intercarpal joint.

In adduction or ulnar deviation, the carpus moves as a whole about an axis in the region of the capitata (os magnum), the carpus closing up as it were, with the greatest displacement occurring at the radiocarpal joint. On the other hand, in abduction or radial deviation, a considerable amount of movement is intercarpal, the series of bones opening up like a fan in complicated adjustive movements.

At the common carpometacarpal and intermetacarpal joints, the range of movement is not great, but is none the less important with respect to the power of the grip. If the fingers are flexed *seriatim*, commencing with the index, it will be noted that each is carried successively to a common point over the ball of the thumb. This movement is functionally significant in not only permitting the fullest flexion of the fingers, but in opposing the frictional surface of the palm to the object grasped. It is brought about by slight rotation of the metacarpals on their long axes around the axis of the index finger, and is therefore greatest in the fifth metacarpal and least in the second. When a fist is made it will be noted by examining the metacarpus, end on, that the series form an arch. The importance of this arch in giving power to the grasp is familiar to every school boy who uses the manoeuvre of flattening out this arch to weaken the grip of his opponent on some fancied treasure. It is familiar too to the clinician, in the weakness of the so-called "flat" hand, which is so often a cause of disability after prolonged immobilization, or as a result of paralysis of the motor component of the movement, as in ulnar-nerve lesions.

From an analysis of these movements and their sites, it will be appreciated that a procedure which arthrodeses the wrist, but preserves the mechanism of the radio-ulnar and carpometacarpal joints, maintains as far as is possible the unity of action of the extremity as a whole. Such a procedure conserves the mechanism of power in the hand by leaving intact the possibility of adjustment at the radio-ulnar joints and motion at the carpometacarpal, and by substituting for the normal locking mechanism at the wrist one of permanency, and therefore losing only the movements of the radiocarpal and intercarpal joints.

DESCRIPTION OF THE OPERATION

The operation for arthrodesis of the wrist requires two incisions,—one over the crest of the ilium for removal of iliac bone, and one for exposure of the wrist joint. To expedite the procedure, it is best to remove the bone from the ilium as the first step, and then proceed with the operation for fusion of the wrist. In this way the transfer of instruments from one wound to the other is avoided. At times an assistant may remove the iliac bone while the surgeon exposes the wrist joint.

Exposure of the Ilium for the Removal of Grafts

The approach to the iliac crest, together with the type of graft which may be removed, has been described in a previous article. For removal

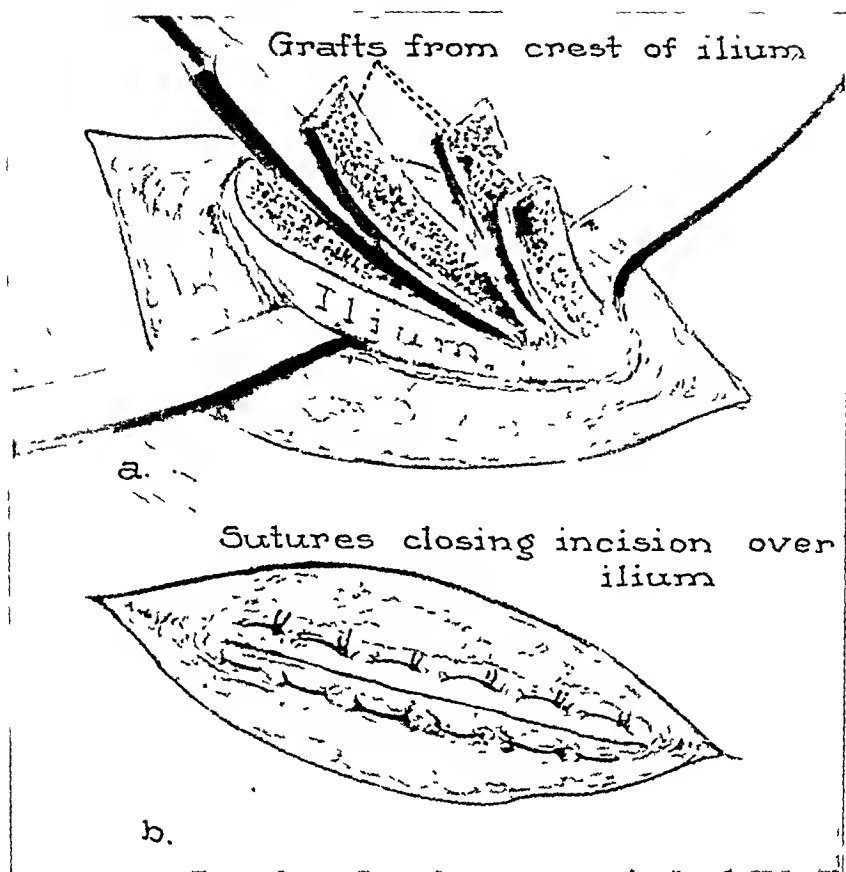


FIG. 1

The method of removal of grafts from the ilium with the osteotome held parallel to its crest.

of grafts for arthrodesis of the wrist, the anterior part of the ilium is exposed by an incision through the skin and subcutaneous tissue along the lateral margin of its crest. The junction of the external oblique muscle above, and the tensor fascia femoris and gluteus medius below, is recognizable as a white line where these muscles blend with the periosteum. Incision is made through the periosteum along this line. The periosteum is then elevated medially and laterally, care being taken to stay as close to the bone as possible in order to avoid bleeding. In children, the technique for exposure of the iliac crest is somewhat different, so as to disturb as little as possible the epiphyseal cartilage which rims the crest. The incision through the periosteum is made along the lateral border of the crest. The glutei are reflected laterally. The cartilaginous portion of the crest is incised along its junction with the bone, and is raised upward and medially. By this method the cartilage is not separated from the musculature of the trunk, and the major part of the blood supply is preserved. When the cartilage is completely elevated, the upper part of the medial surface of the ala or iliac fossa is exposed. The grafts are

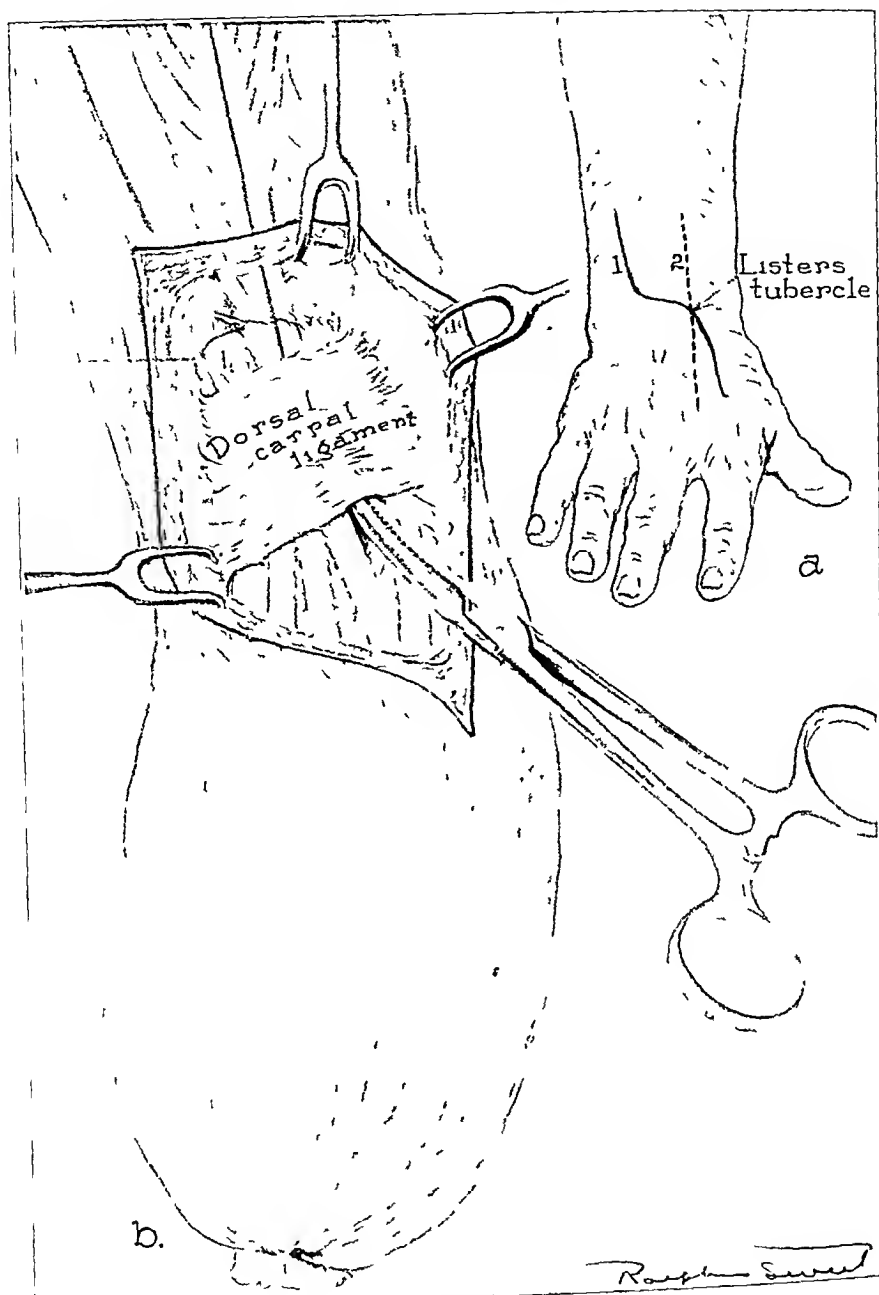


FIG. 2

a: Curvilinear and straight incisions with their centers over the dorsal tubercle of Lister.

b: Exposure of the dorsal carpal ligament which covers the sheaths of the common extensor tendons of the wrist and fingers. The point of the hemostat indicates the site of the incision through the ligament and periosteum on the lower end of the radius.

removed with an osteotome held either vertical to or parallel with the crest. In this way, grafts of various types can be obtained. For fusion of the wrist joint, grafts are removed with the osteotome held parallel to the crest (Fig. 1*a*).

The method of repair after the removal of the grafts is of great importance to the patient's postoperative comfort, and to an early resumption of activity. The periosteal attachments of the muscles of the trunk and thigh are firmly sutured together over the iliac crest, employing interrupted figure-of-eight sutures of No. 1 braided silk (Fig. 1b). In cases where small chip grafts have been removed, patients may walk without crutches in three weeks.

Exposure of the Wrist Joint

A blood-pressure cuff is used as a tourniquet. An incision which may be straight, or preferably curvilinear, is made over the posterior aspect of the wrist with its center over the dorsal tubercle

of Lister (Fig. 2a). The latter is a bony projection on the dorsal surface of the lower end of the radius, which separates the extensores carpi radialis longus and brevis from the extensor digitorum communis. On retraction of the skin and subcutaneous tissue, the dorsal carpal ligament is exposed, and the several fibrous partitions which separate the tendon sheaths over the lower parts of the radius and ulna are clearly seen (Fig. 2b). This ligament, together with the periosteum, is incised vertically over Lister's tubercle. The posterior aspect of the lower end of the radius is exposed subperiosteally, care being taken to preserve as far as possible the tendon sheaths of the extensor pollicis longus, the extensores carpi radialis longus and brevis, and the extensor digitorum communis. These tendon sheaths are retracted to the radial and ulnar sides, in order to expose the dorsal aspect of the radiocarpal and intercarpal joints (Fig. 3). The posterior ligament of the radiocarpal joint is incised horizontally along the lower margin of the radius (Fig. 4). The wrist is then held in palmar flexion while the cartilage is removed with a special gouge from the lower end of the radius and the upper surfaces of the navicular and lunate (semilunar) bones. The intercarpal and the transverse intercarpal joints are exposed *en masse* by turning distally, with the aid of an osteotome, a curved flap, consisting of the fibrous capsule of these joints together with a thin section of cortex from the posterior surfaces of the navicular, lunate, and capitate bones.* In adults, a thin flap of bone from the dorsal aspect of the radius is then cut and turned upward with an osteotome (Fig. 5).

* The above method was described to the writers by J. Albert Key, M.D., of St. Louis.

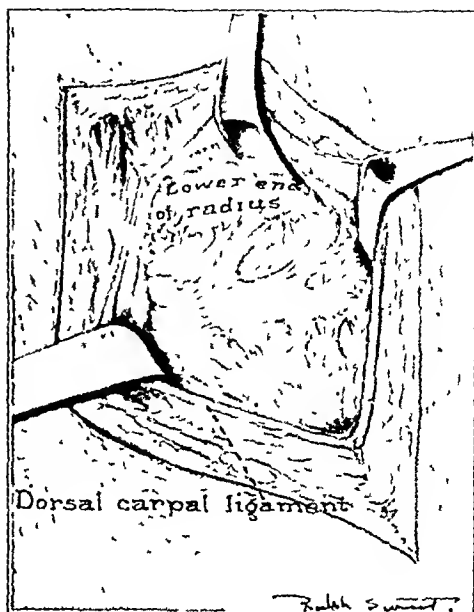


FIG. 3

The periosteum on the lower end of the radius has been reflected, and the radio-carpal and intercarpal ligaments are seen.

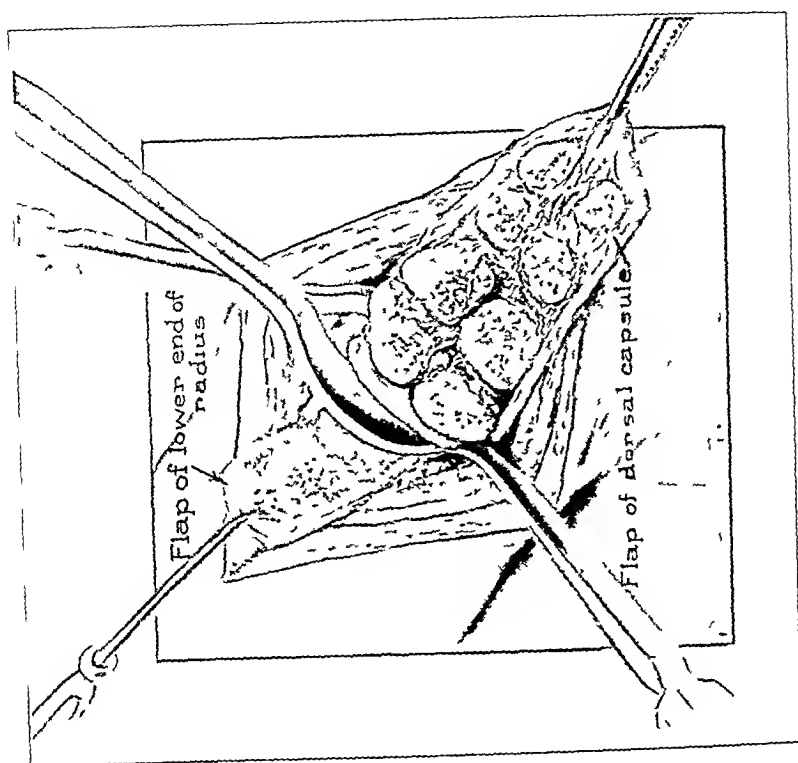


FIG 5

The flaps are raised and the radiocarpal and intercarpal joints are exposed. The cartilage is removed from the radiocarpal joint with a curved gouge.

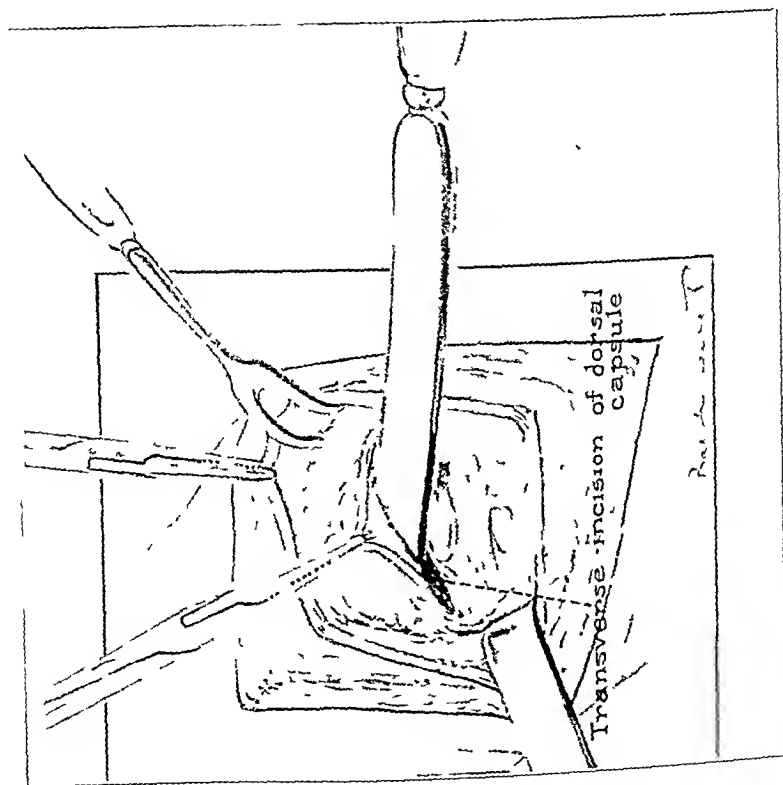


FIG 4

The radiocarpal joint is opened through a transverse incision. The beginning of the osteotomy of the lower end of the radius and the dorsal flap is shown.

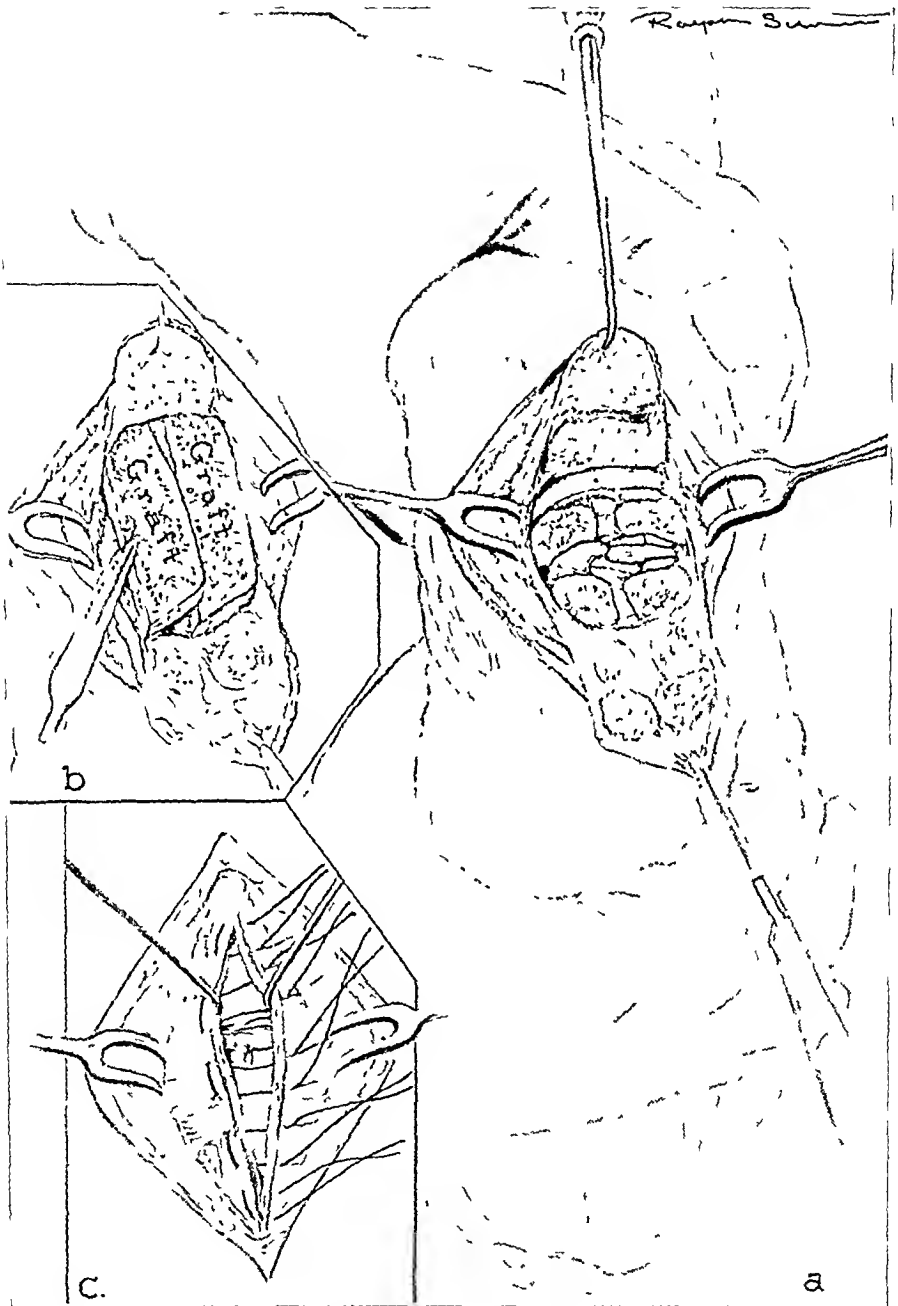


FIG. 6

a Curved grafts are placed in the radiocarpal joint, and chip grafts are fitted into the intercarpal and transverse intercarpal joints.

b Long grafts cover the lower end of the radius and the denuded carpal bones. The ends of the grafts are tucked beneath the bases of the radial and carpal bone flaps.

c The margins of the flaps are approximated with mattress sutures lying deep in the transverse plane. Vertical mattress sutures close the dorsal carpal ligament.

In children, after a similar exposure of the joints, a horizontal cut is made on the articular surface of the lower end of the radius into which the grafts

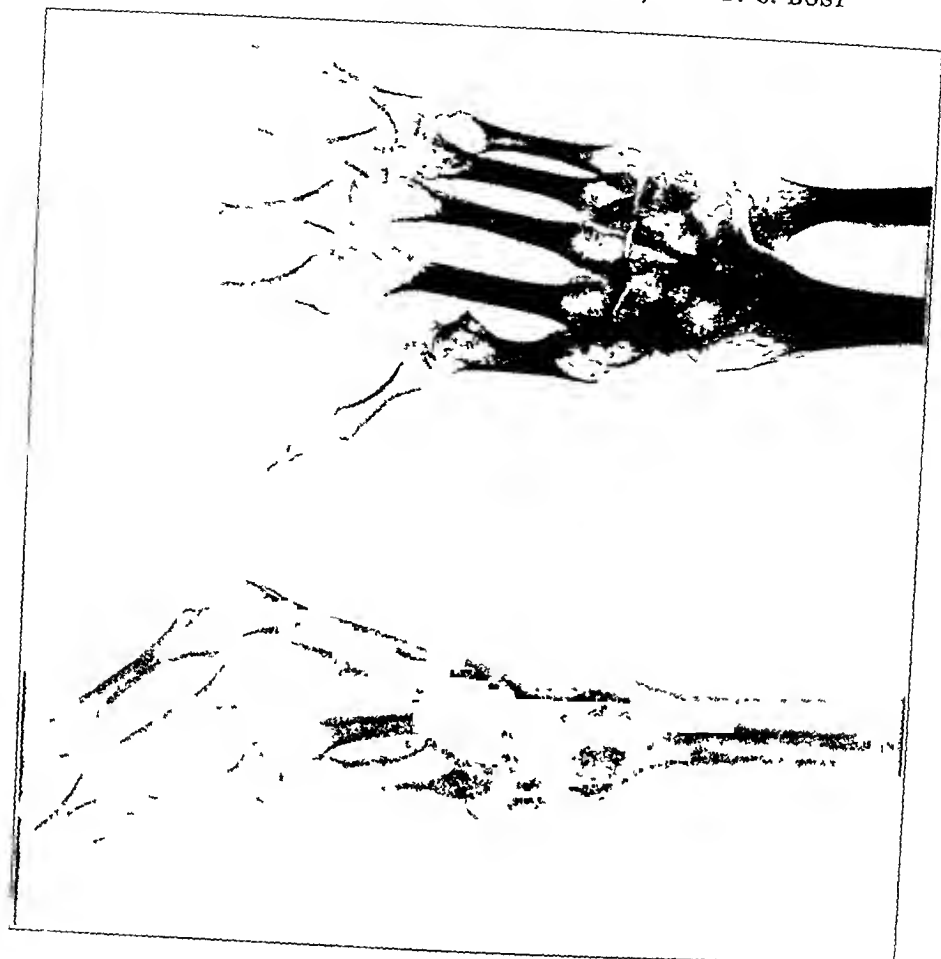


FIG. 7

Fusion of the wrist joint is solid. Note the trabeculation passing from the lower end of the radius to the carpus.

are eventually fitted, thus avoiding injury to the epiphyseal line. With a curette and sharp knife, the cartilage is removed from the inferior surfaces of the navicular, lunate, capitate, and, if readily accessible, the surface of the lesser multangular (trapezoid). The spaces between the denuded surfaces of the carpal bones and the lower end of the radius are packed with chips of cancellous bone derived from the ilium, and broad, pliable sections from the same source are then placed over the entire posterior aspect of the radiocarpal, intercarpal, and transverse intercarpal joints (Figs. 6a and b). Fixation of these grafts is secured by first tucking their upper and lower borders beneath the bases of the bone flaps which were raised from the posterior aspect of the carpus and radius, and later securing them by dorsal flexion of the wrist. The inferior radio-ulnar and the carpometacarpal joints are not exposed. The preservation of movement at the inferior radio-ulnar joint allows for normal rotation of the forearm, and for the pistonlike action of the radius on the ulna, which is essential for good function of the wrist and hand. As the carpometacarpal joints are left intact, the metacarpal arch of the hand is maintained, and the power and strength

of the grasp is preserved. Moreover, the few degrees of motion remaining in these joints allow sufficient movement to absorb the shocks encountered in the course of every-day activity (Fig. 7).

The wound is closed by silk sutures which approximate the margins of the bone flaps, the periosteum on the lower end of the radius, and the ligaments (Fig. 6c). A plaster-of-Paris cast is then applied, which extends from the upper arm to the tips of the fingers and the thumb, with the elbow held at a right angle and the forearm in the mid-prone position. The wrist is fixed in from 10 to 15 degrees of dorsal flexion, while the joints of the thumb and fingers are moderately flexed. The cast is carefully molded about the wrist and the palmar surfaces of the hand and fingers, and is cut over the back of the wrist and forearm to allow for swelling. At the end of three weeks, a second short plaster cast, extending from just below the elbow to the metacarpophalangeal joints, is applied. The position of the wrist is checked carefully at this time.

DISCUSSION

The relative merits of cancellous and cortical bone have been emphasized in a previous paper. In that publication it was stated that cancellous bone is more rapidly revascularized and revitalized by living bone than is cortical bone. It is plastic and can be molded to surfaces of varying contours. Consequently the application of grafts is less difficult than when cortical bone is employed. The writers have found cancellous bone to be especially adaptable in arthrodesis of the wrist. In addition, the risk of complications is greater when grafts are removed from the tibia. Fractures of this bone at the site of the removal of the graft are not infrequent, and may occur even after the lapse of six months.

In a series of forty-eight cases, for which complete histories and follow-ups are available, arthrodesis of the wrist was performed fifty times; sixteen for spastic paralysis, six for Volkmann's ischaemic paralysis, thirteen for the residual paralysis of acute anterior poliomyelitis, three for traumatic arthritis, three for obstetrical paralysis, four for injuries to peripheral nerves, three for tuberculosis of the wrist, and two in a case of bilateral congenital deformity of the forearm. It was not possible to record accurately the exact time of fusion in each case. However, in the more recent cases, the average time for firm fusion has been ten weeks, the earliest being eight weeks. This procedure is applicable to both adults and children. Although the youngest patient in this series was eight years of age, it is usually inadvisable to operate on children under the age of twelve years because of insufficient bone development. In only one patient, an adult, fusion did not occur over a period of two years. This case has been classified as a failure.

For paralytic conditions, both spastic and flaccid in character, with extensive involvement of the muscles of the forearm and hand, it should be emphasized that fusion of the wrist is the essential procedure for permanent improvement in function. Other operations, such as transplanta-

tion of tendons, should be regarded as purely supplementary. Therefore, arthrodesis of the wrist is of the same basic importance in reconstructive work for paralytic conditions of the upper extremity as stabilization of the foot in similar paralytic conditions of the lower extremity. In cases of spastic paralysis with palmar flexion of the wrist and fingers, a partial neurectomy of the median nerve has been employed as a preliminary procedure, and is of value because it relaxes the spasm of the flexor muscles and prevents the recurrence of deformity.

Stabilization of the wrist should be regarded as one of the most important reconstructive operations for permanent paralysis of the upper extremity, due to injury to the peripheral nerves. This is especially true in cases of complete paralysis of the muscles supplied by the radial nerve. If motion in the inferior radio-ulnar and carpometacarpal joints is not disturbed by the operation, the patient misses but little the motion of the radiocarpal and intercarpal joints. Loss of motion in these joints is more than compensated for by their stability. It is the experience of

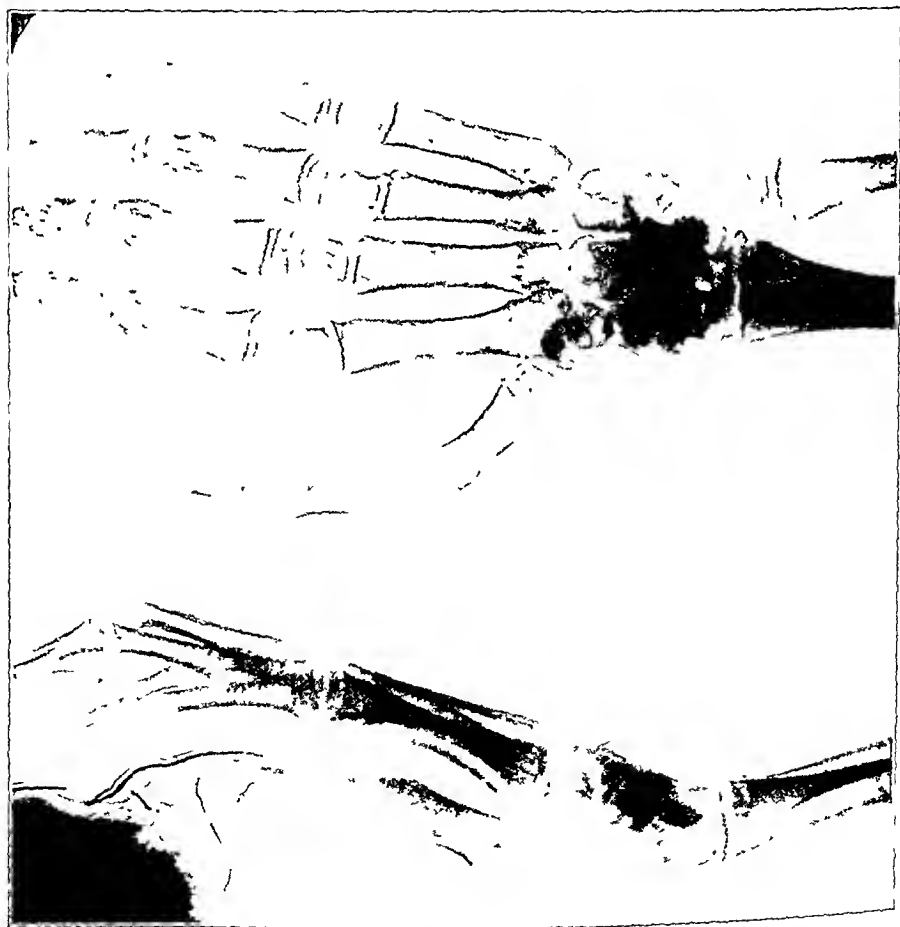


FIG. 8-A

Case 4. L. B. Three weeks after operation there is fusion of the radiocarpal and transverse intercarpal joints.

the writers that in injuries to the radial nerve, the results of fusion of the wrist combined with transplantation of tendons have been far superior to the transplantation of tendons alone. Furthermore, this combination of fusion of the wrist with transplantation of tendons has been equally useful for the repair of the extensive muscle damage in Volkmann's ischaemic paralysis.

Arthrodesis of the wrist is indicated also in cases of arthritis of the wrist joint of both traumatic and infectious origin. Frequently it is the means by which a tuberculous wrist can be healed. When draining sinuses and secondary infection are present, an operation to obtain fusion at the wrist with the use of bone grafts is sometimes condemned because the grafts generally fail to unite and are extruded from the wound. In two instances of this type, however, fusion was secured by excision and the use of grafts of cancellous bone. In both cases healing of the sinuses and bony ankylosis were obtained.

The following cases are presented to illustrate each type of condition for which arthrodesis of the wrist has been performed.



FIG. 8-B

Twelve weeks after operation there is firm fusion of the radiocarpal and transverse intercarpal joints, with preservation of motion in the inferior radio-ulnar and carpo-metacarpal joints.

CASE 1. A. H., eighteen years of age, entered the University of California Hospital on March 19, 1940.

The patient had sustained a supracondylar fracture of the left humerus at the age of fifteen years. One week after the injury an open reduction had been performed. The complications which followed the operation were a wrist-drop, infection, and subsequent osteomyelitis. Sequestrectomy had been carried out before he entered the University Hospital.

Examination revealed a united supracondylar fracture of the humerus, and a complete interruption of function of the radial nerve. The neurological surgeons were of the opinion that the injury and infection had caused a loss of substance of the nerve, and that an exploration would be of no benefit. Therefore, on March 22, 1940, the wrist was arthrodesed. Two months later a second operation was done consisting of transplantation of the extensor carpi ulnaris to the abductor pollicis longus, extensor pollicis brevis, and the extensor pollicis longus, transplantation of the palmaris longus to the extensor indicis proprius, and transplantation of the flexor carpi radialis to the common extensors of the third, fourth, and fifth fingers.

On May 21, two months after arthrodesis of the wrist, clinical examination and roentgenograms showed complete fusion. One month after the tendon transplantations, the patient had a strong wrist, with full flexion and extension of the fingers and a powerful grasp.

CASE 2. H. H., aged sixteen years, entered the Children's Hospital on July 6, 1939.

The diagnosis was spastic hemiplegia, a condition which had been present since the age of two months.

This patient had been hospitalized on a previous date, and a partial neurectomy of the popliteal nerve had been performed to correct an equinus deformity of the foot. At this time examination showed a flexion deformity of the wrist and fingers with marked spasticity of the flexor muscles. On July 11, 1939, a partial neurectomy of the median nerve resulted in considerable diminution of the spasm of these muscles. In October 1939 the nerve supply to the muscles of the thumb was partially divided, and following this the thumb was in a better position, and there was less muscle spasm.

On December 4, 1939, an arthrodesis of the right wrist was done. Three months later there was solid fusion of the joint with marked functional improvement.

CASE 3. D. R., aged eighteen years, entered the Children's Hospital on July 1, 1940.

The diagnosis was Erb's palsy. The left wrist was held in palmar flexion, and there was very little function of the fingers. On July 11, 1940, an arthrodesis of the wrist and of the carpometacarpal joint of the left thumb was performed.

On September 5, 1940, roentgenograms showed bony fusion of these joints. Ten weeks later, there was firm fusion of both the wrist and thumb, with improvement in function of the extensors and flexors of the digits.

CASE 4. L. B., eleven years of age, entered the University of California Hospital on July 15, 1940.

The patient had had anterior poliomyelitis at the age of five years, the sequel of which was a residual paralysis of the right forearm. Conservative treatment had been carried out earlier with little improvement.

There was extensive paralysis of the muscles of the forearm and hand, the only good muscles being the extensores carpi radialis longus and brevis. However, there was some power of flexion in the flexor sublimis of the third and fourth fingers.

On July 18, 1940, arthrodesis of the left wrist was performed. Three weeks after the operation, fusion of the radiocarpal joint was beginning to take place (Fig. 8-A). In twelve weeks, there was complete fusion of the radiocarpal joint, and of the radial half of the intercarpal joints (Fig. 8-B).

On November 16, 1940, the tendons of the flexores sublimis of the index and of the fifth finger were joined to the third and fourth fingers respectively. In March 1941, the

extensor carpi radialis longus was transplanted to the extensor pollicis longus, and the extensor carpi radialis brevis was transplanted to the extensor digitorum communis. In August 1911, there was a very marked improvement in function.

CASE 5. A. M., aged eighteen years, entered the University of California Hospital on December 5, 1938.

The diagnosis was Volkmann's ischaemic contracture.

The patient had sustained a fracture of the left forearm near the elbow at the age of seven years. Following the fracture a Volkmann's ischaemic paralysis had developed. At the time of his admission to the Hospital, he showed the typical flexion contracture of the wrist and interphalangeal joints.

Early treatment consisted of a plaster cast which was wedged to correct the contractures of the tendons. It was impossible to obtain complete correction because of the bone deformity at the wrist. On December 7, 1938, this deformity was corrected by excision of the proximal row of carpal bones. These bones were sectioned for grafts. The distal row of carpals and the lower end of the radius were approximated, and this junction was covered with the grafts.

On April 27, 1939, the extensores carpi radialis longus and brevis were transplanted to the tendons of the flexor digitorum profundus.

In November 1939, the flexor carpi ulnaris was sutured to the extensor pollicis brevis on the anterior aspect of the wrist, a loop being formed by a part of the tendon of the flexor carpi ulnaris in the region of the pisiform bone.

On March 14, 1941, the wrist was solidly fused and the tendon transplants were functioning well.

CASE 6. P. P., aged sixty-five years, entered the Franklin Hospital on October 17, 1939.

For forty years the patient had had pain in the right wrist. His symptoms were not severe in character until 1936, when the wrist became swollen and extremely painful. In October 1936, the wrist had been excised by another surgeon, and a diagnosis of tuberculosis had been made. Since that time, there had been repeated flare-ups accompanied by pain and swelling, and ultimately by discharging sinuses.

Examination revealed a painful wrist with diffuse swelling of the soft-part structures, and several sinuses which discharged purulent material.

In October 1939, roentgenograms showed marked destruction of the lower ends of the radius and ulna, and of the proximal row of carpal bones. The disability was increasing, and the patient had little use of the hand.

On October 18, 1939, an arthrodesis of the wrist was performed. The lower ends of the radius and ulna were excised, and removal of the first row of carpal bones and partial resection of the distal row of carpal bones were carried out. Cancellous bone was transplanted from the ilium to promote fusion. The wounds were left open because of the infected sinuses. Convalescence was uneventful.

Eight months later roentgenograms showed bony union between the distal row of carpal bones and the lower ends of the radius and ulna. A slight discharge remained from a small sinus over the dorsal aspect of the lower end of the ulna.

On August 15, 1941, the wound was healed except for a small abrasion in the region of the lower end of the ulna. The wrist was rigid and painless.

CASE 7. J. K., thirty-five years of age, entered the San Francisco Hospital on April 15, 1935.

The patient had had influenza at the age of eighteen years, which was followed by pleurisy. Six months before he entered the Hospital he experienced pain on the distal aspect of the left radius. This area soon became swollen and inflamed.

Early treatment consisted of fixation in a plaster cast and the incision of abscesses. Acid-fast organisms were found in the pus.

On August 14, 1936, the carpus was partially excised and an arthrodesis of the wrist was performed. Six months later, the wrist was solid and painless.

CASE 8. J. A., twenty-seven years of age, entered the San Francisco Hospital on August 3, 1938.

A diagnosis of tuberculosis had been made in 1935, at which time an arthrodesis of the right ankle had been performed. Three months before he entered the Hospital, the patient had fallen and injured his left wrist. A few months after the injury, clinical and roentgenographic examinations showed evidence of tuberculosis of this joint.

On April 12, 1940, an arthrodesis of the left wrist was performed. Three and one-half months after the operation, the wrist was solidly ankylosed in good functional position.

SUMMARY

1. The writers wish to stress the importance of arthrodesis of the wrist for the improvement of function in disabilities arising from various paralytic conditions which affect the upper extremity. The operation has also been used successfully in the treatment of traumatic and infectious arthritis, particularly in cases of tuberculous origin.

2. This operative technique presents a method for securing rapid and certain fusion of the wrist with the use of grafts of cancellous bone from the ilium. Cancellous bone has advantages over compact bone.

3. An understanding of the surgical and functional anatomy of the wrist in performing arthrodesis of the wrist is important, because preservation of motion in the inferior radio-ulnar and carpometacarpal joints has functional value.

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SPONDYLOLISTHESIS *

REPORT OF THREE CASES IN ADULTS WITH FORWARD DISPLACEMENT OF THE VERTEBRA BELOW THE LEVEL OF THE LAMINAR DEFECT

BY SAMUEL KLEINBERG, M.D., AND MICHAEL S. BURMAN, M.D.,
NEW YORK, N. Y.

It has been the consensus that the essential factor or *sine qua non* in spondylolisthesis is a bilateral laminar defect separating the posterior arch from the body of the vertebra. Moreover, according to all records, the slipping always occurred in the vertebra with the laminar defect. The cases here reported seem unusual for several reasons:

1. The vertebra which became displaced was not the one with the laminar defect, but the one below it.

2. In one of the cases, the laminar defect was apparently unilateral, the subluxation occurring with the apophyseal joint of the uninjured side as the center of rotation.

3. In each instance, there was a trauma adequate to produce a fracture of the laminae; the symptoms appeared after the injury; and hence it seems possible that the slipping resulted from a laminar fracture,—that is, that the spondylolisthesis was of traumatic origin.

4. Although the patients were all adults, the slipping in each instance was only mild.

5. In two of the patients, the laminar defects appeared identical in location and extent, and there was a similar displacement and rotation of the posterior arches.

It remains for future experience to determine whether these findings necessarily indicate that the laminar defect is congenital, and militate against the suggestion that the spondylolisthesis is of traumatic origin.

CASE REPORTS

CASE 1. J. K., a male, forty-four years old, was apparently well until November 11, 1938, when he lifted a cylinder of oxygen onto a truck. In this act he felt a very sharp pain in the right lower back, and was unable to straighten up. Several minutes later he was able to continue driving the truck. His discomfort continued, and, after several days, he consulted a physician who strapped his back and advised him to continue working. His pain increased, and he was provided with a low-back belt. He continued to work, wearing the belt, until February 1940 when one morning he found that he could not get out of bed because of intense backache. He has not worked since then.

Physical examination showed that the patient was muscular and well built, walked without a limp, and was able to undress and dress without assistance. His back was symmetrical. There were no undue prominences or depressions in any part of his back, and there was no break in the anteroposterior contour of the spine, such as is commonly seen in the typical spondylolisthesis. Flexion and extension of the spine were normal.

* Read before the Orthopaedic Section of the New York Academy of Medicine, February 20, 1942.

Lateral inclination to the left caused pain in both iliolumbar angles, while lateral inclination to the right caused pain in only the right iliolumbar angle. The side motions of his spine, however, were free. Jarring his head did not cause any pain in the back. Jumping down on his heels caused discomfort in the lumbosacral area and in both loins. There was marked tenderness to pressure over the lumbosacral region and to a less extent in both loins.

The lateral roentgenogram (Fig. 1-A) shows a forward displacement of the body of the third lumbar vertebra of at least one-quarter of an inch. There is a reduction in the intervertebral space between the second and third lumbar vertebrae, and sclerosis, and

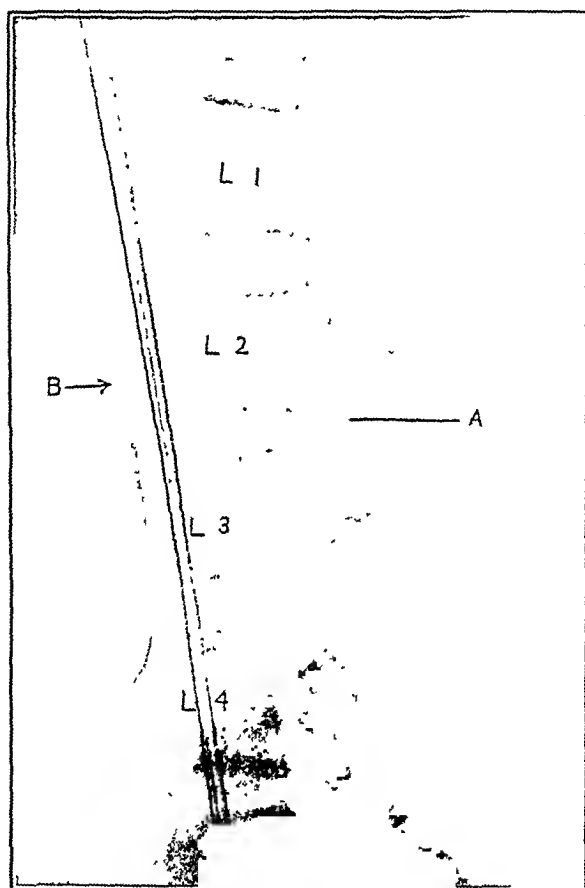


FIG. 1-A

Case 1. J. K. Lateral view of the lumbar spine. There is a forward displacement of the third lumbar vertebra. At A note the reduction of the intervertebral foramen between the second and third lumbar vertebrae. The intervertebral disc between the second and third lumbar is smaller than it should be. At B there is ossification of the anterior longitudinal ligament and spur formation.

defect is in the second lumbar. In explanation of this rare and certainly unusual pathology, the authors are led to the hypothesis that the body of the second lumbar was so thoroughly bound to the first lumbar that the injury, which either caused the laminar defect by fracture or aggravated a previously existing congenital defect by stretching or tearing the fibrous

hyperostosis of the lower anterior portion of the body of the second lumbar. The articular facets of the second and third lumbar vertebrae appear to be closer than any of the other articular facets (this is seen more clearly in the original film than in the reproduction). The intervertebral foramen between the second and third lumbar vertebrae is smaller than any of the others. In an oblique view (Fig. 1-B) the laminar defect is clearly visualized. There is visible an irregular solution of continuity, possibly a fracture (seen perhaps more clearly in Figure 1-C), through the base of each inferior articular facet of the second lumbar vertebra,—that is, the posterior arch of the second lumbar is separated from the body with a wide gap between the fragments on the left side (A) and a narrower separation on the right side (B). The whole of the posterior arch appears displaced downward and to the right, and rotated on an anteroposterior axis, so that it is lower on the left than on the right side.

This is an instance of spondylolisthesis of the third lumbar vertebra, although the laminar de-

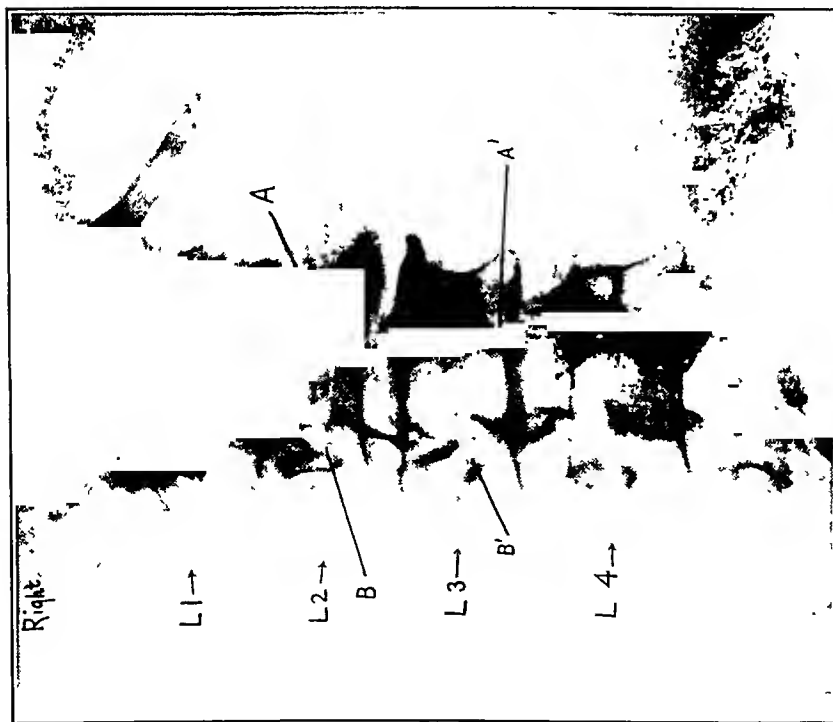


Fig. 1-B

Oblique view of the lumbar spine. At *A* and *B* are seen the fractures of the laminae at the bases of the inferior articular facets. The fractured posterior arch of the second lumbar vertebra appears displaced downward and rotated to the right. Note particularly that at *A'* and *B'*, the bases of the inferior articular facets of the third lumbar, there is no solution of bone continuity.

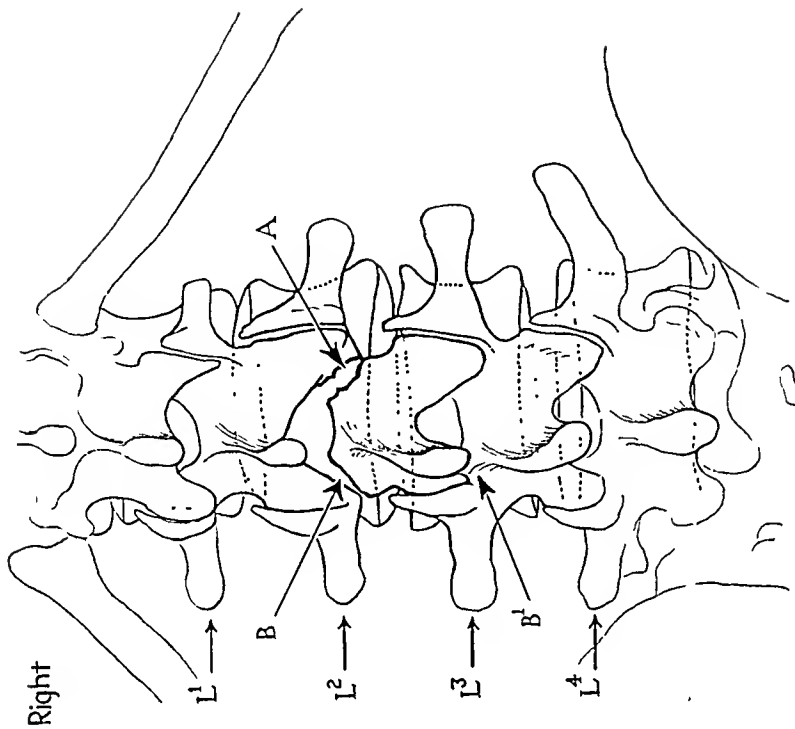


Fig. 1-C

Pen sketch of the previous roentgenogram to outline more clearly the laminar fracture and displacement of the posterior arch.

tissue bridging the laminar defect, precipitated the forward slipping of the third lumbar vertebra with the attached posterior arch of the second lumbar. One should certainly keep an open mind on the nature of the laminar defect in the second lumbar. Perhaps it was congenital but was not previously recognized in this patient. However, in view of the facts: (1) that this patient had not had any symptoms referable to his back prior to the injury; (2) that the symptoms came on directly after the injury and persisted; and (3) that fracture of vertebral processes can occur through severe muscle effort, it seems possible and likely that the defects in the laminae were actually fractures and that the spondylolisthesis was traumatic in origin.

CASE 2. A. I., a man of forty-nine years, was first seen on September 12, 1936, when he complained of backache of about two years' duration. In November 1934 he was in an automobile accident, the car in which he was riding being turned over. He did not recall any direct injury to his back, but he remembered that he did have pain in his back after the accident. He was able to leave the overturned car by crawling through a window. The sequence of events was not well remembered. He knew that his back was stiff and painful after the accident. About six months later a severe left sciatica developed of which he was relieved by injections.

At the time of the first examination, he had pain in the lower back radiating to the left hip. The pain was steady and dull, and was aggravated by rainy weather. He had noted no loss of sensation or strength in the lower extremities. The trunk was tilted to the right about 10 degrees. Flexion of the spine was free, and extension was almost normal. Left lateral bending was much limited, but right lateral bending was fairly free. The spinous processes of the third and fourth lumbar vertebrae were tender to pressure. There was no other point of tenderness in the back, and none over the course of either sciatic nerve. Straight-leg raising was normal on both sides. There were no sensory or motor disturbances, and the reflexes were normal.

The roentgenograms showed in the anteroposterior view (Fig. 2-A) a bilateral laminar defect, probably a fracture, of the second lumbar vertebra (*A* and *B*). The defect extended completely through each pedicle of the second lumbar vertebra, so that the posterior arch (*C*) was separated from the vertebral body, displaced downward, and rotated to the right, thus showing more of the right lamina than the left, while its spinous process was deviated to the left. The interval between the displaced laminae and the vertebral body was greater on the right than on the left side. The laminar surfaces, especially on the right side, were irregular. In addition, there was a linear defect or fracture through part of the right lamina of the third lumbar. The lateral view (Fig. 2-B) showed a mild forward slipping of the *third and the superimposed lumbar vertebrae* on the fourth lumbar.

This patient was hospitalized and treated by recumbency on a convex frame. In a short time his back became symmetrical, the spinal motions increased, the muscle spasm relaxed, and his pain was relieved. Thereafter his back was supported by a Knight spinal brace. He was last seen in December 1936, at which time new roentgenograms showed no union of the laminar fractures.

This patient exhibits a lesion of the posterior arch of the second lumbar vertebra identical with that seen in the previous case. The second lumbar vertebra did not become displaced as in the usual spondylolisthesis. Neither did the third lumbar and those below it slip forward as in Case 1. Instead the third lumbar and those above it were displaced forward on the fourth lumbar. The mechanism in the first case is clear. The third lumbar vertebra with the attached posterior arch of the second

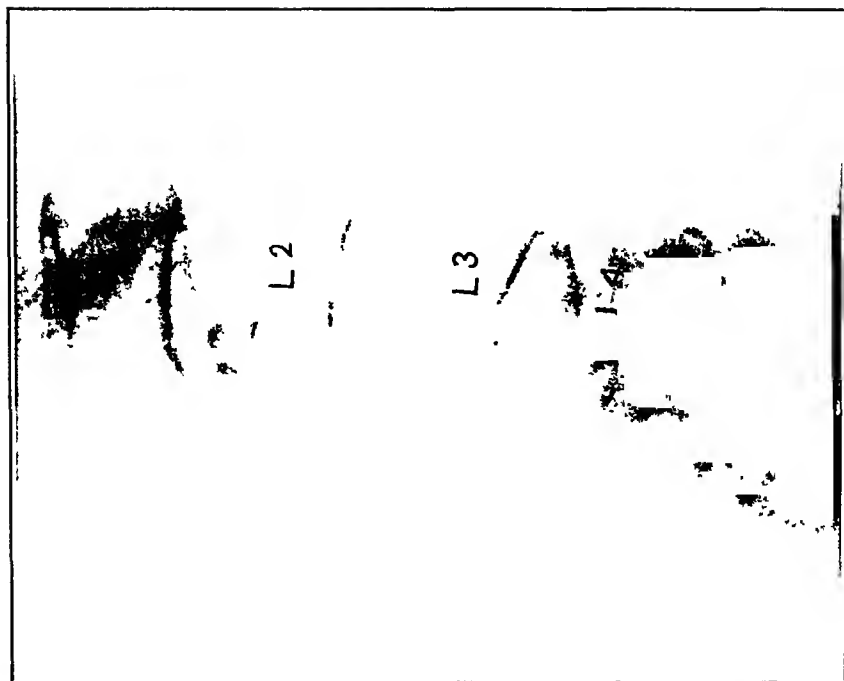


Fig. 2-B

Lateral view showing forward displacement of the third lumbar vertebra on the fourth.

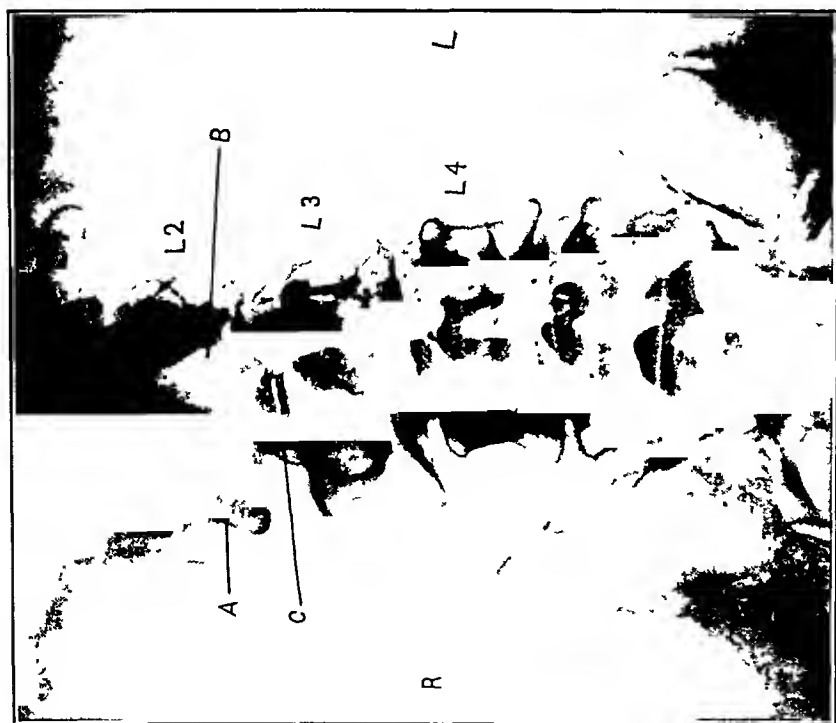


Fig. 2-A

Case 2. A. I. Note the bilateral fracture of the posterior arch of the second lumbar vertebra and the irregularity of the fractured surface of the right lamina. At A and B the separation of the posterior arch (C) from the body of the second lumbar is seen.

lumbar now released from the body of the second lumbar, slipped forward carrying with it the securely attached vertebrae below it; but in this case the third lumbar and those above it slipped forward *en masse* on the fourth lumbar. This would seem explicable if the linear fracture of the right lamina of the third lumbar was more extensive than is discernible in the roentgenogram, and the rotation would indicate that it occurred about an intact left lamina as an axis.

In this case, as in the previous one, the authors are mindful of the fact that the laminar defect in the second lumbar may be congenital.

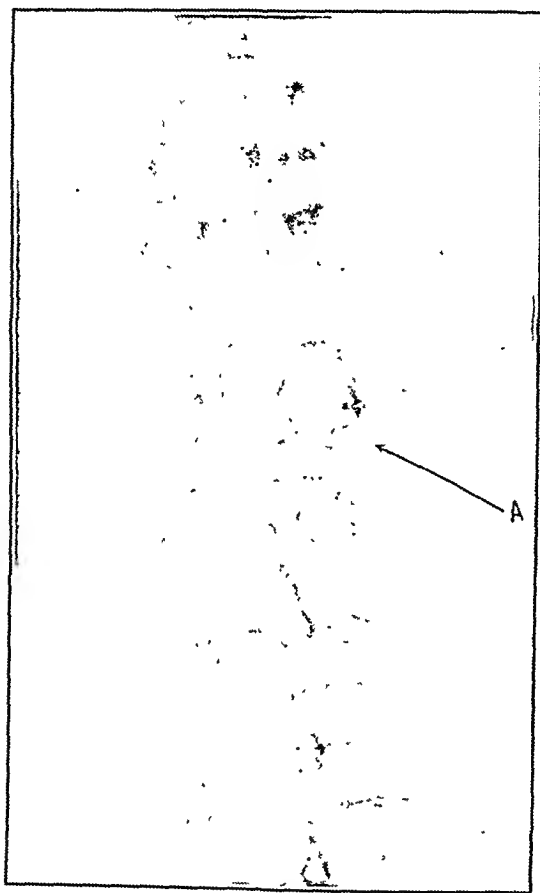


FIG. 3-A

Case 3. J. R. Anteroposterior view. Note the transverse fracture of the left lamina of the twelfth thoracic vertebra and the displacement and rotation of the first lumbar to the right.

from the floor. Lateral motions and rotation of the back were very much limited. There was less limitation of extension. The region of the first lumbar spinous process and the region of the lumbosacral joint were very tender to pressure. Straight-leg raising on the right side was restricted, because of pain in his back. Other leg tests gave pain in the back, and he voluntarily restricted the performance of these tests. Neurological examination was negative.

Roentgenograms disclosed in the anteroposterior view (Fig. 3-A) a linear defect, probably a fracture, of the left lamina of the twelfth thoracic vertebra. This defect ran

However, because of the known injury, the irregularity of the laminar surfaces, and the linear defect in one lamina of the fourth lumbar, it would seem possible and very likely that the defect in the posterior arch of the second lumbar is the result of a fracture produced by the described injury.

CASE 3. J. R., a man of sixty years, was standing in a bus. The bus made a sudden turn with a violent jerk, so that the man was thrown to the floor. He struck the thoracolumbar region of his back against a step with a good deal of force. His back, he believes, was arched in hyperextension at the moment of injury. He complained of sharp pain at the site of injury, non-radiating in character. He became unable to bend or lift, and the pain was severe enough to keep him awake at night.

Examination on the day of the injury showed a short, slender, well-muscled man. He walked slowly,

the trunk inclining to the right and forward. The lower thoracic and lumbar muscles were spastic. Flexion was possible to twelve inches

transversely, and extended into the left articular process (A). The first lumbar vertebra was luxated anteriorly (Fig. 3-B) and to the right. This luxation was associated with a rotation of the first and second lumbar vertebrae to the right. Advanced osteo-arthritis spurring was seen in the thoracic and lumbar vertebrae.

These roentgenographic findings were confirmed by stereoscopic examination of the thoracolumbar spine. It was noted that the fracture line of the left lamina of the twelfth thoracic vertebra extended to the base of the spinous process. The right apophyseal joint between the first and second lumbar vertebrae was widened.

A high plaster-of-Paris jacket was applied, which was replaced by a corset soon afterward. He is wearing this corset with relief. There is still limitation of motion and muscle spasm, and it is interesting to note that the greatest tenderness is located over the area of the lumbosacral joint.

It is believed that the luxation and rotation of the bodies of the first and other lumbar vertebrae are the result of the fracture of the left lamina of the twelfth thoracic vertebra, the first lumbar vertebra swinging upon the intact right lamina of the twelfth thoracic as if on a hinge. The widening of the right apophyseal joint between the first and second lumbar vertebrae is secondary to this movement.



FIG. 3-B

Lateral view showing forward displacement of the first lumbar vertebra.

DISCUSSION

These three cases of spondylolisthesis have one common finding,—namely, that after bilateral laminar damage in two cases and unilateral laminar injury in one, *the vertebra below the injured one* became subluxated anteriorly. In this regard these cases of spondylolisthesis differ from those commonly seen, and considered to be of congenital origin, in which the dislocation is of the vertebra with the laminar defect, and not of the one below it. Whether this feature is peculiar to a traumatic spondy-

lolisthesis the authors are not prepared to say. Conceivably and possibly the laminar defect in the first two cases was congenital, and the slipping was brought on by the trauma, severe in each case, which caused not only forward slipping, but a rotation of the vertebra.

In none of these cases was there consent for what would appear to be the treatment of choice,—namely, a spine fusion. Yet it would seem logical that, in the presence of such extensive injury and displacement, instability with recurrent or continuing symptoms is exceedingly likely, and hence an ankylosing or stabilizing operation is warranted and advisable.

SUMMARY AND CONCLUSION

These three cases of spondylolisthesis in adults were probably caused by laminar fractures. In two of the patients there were bilateral defects or fractures, and in one a unilateral defect. In the two cases with bilateral laminar defects, the posterior arches were displaced and rotated in identical ways. The vertebral displacement or slipping was unusual in that it occurred in the vertebra below that with the laminar lesion. The spinal motions in all of the patients were comparatively free.

The treatment of choice in these cases would seem to be a spine fusion to prevent chronic pain and disability.

FUSION OF THE METACARPALS OF THE THUMB AND INDEX FINGER TO MAINTAIN FUNCTIONAL POSITION OF THE THUMB*

BY CHARLES F. THOMPSON, M.D., INDIANAPOLIS, INDIANA

The use of autogenous bone graft to fuse the metacarpal of the thumb to that of the index finger, for restoration of opposition of the thumb, has proved itself sufficiently to justify its presentation as a useful means of rehabilitating the crippled hand. Foerster in 1931 reported the use of this type of bone graft in a paralytic hand. Allan of Birmingham reported the results in forty-three patients in whom he had restored opposition of the thumb to the fingers by this method of bone fusion.

Stabilization of the metacarpal of a thumb paralyzed by anterior poliomyelitis may be considered as a final step in surgical reconstruction of the hand. Such an operation should not hold precedence over transplantation of tendons. However, if muscle transplants have been unsuccessful, bony fixation of the metacarpal of the thumb may still improve grasping function of the thumb and fingers. This operation is also useful in maintaining the spastic thumb away from the palm; likewise it has proved itself to be of value in hands damaged by wounds in the forearm and wrist.

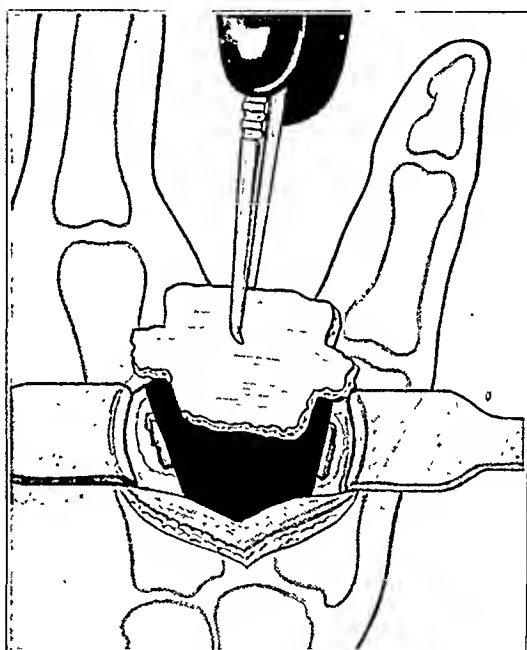


FIG. 1

Technique of insertion and fixation of bone graft between metacarpals.

The following points in the technique of this use of autogenous bone graft should

be emphasized and adhered to to assure the most satisfactory results:

1. Exposure of the first interosseous space is obtained by dorsal longitudinal incision, and deep dissection must include isolation of the radial artery. The first dorsal interosseous muscle, whether atrophied or not, is carefully split, and preserved to cover the dorsal aspect of the graft. The adductor pollicis or its remnant forms the floor of the graft bed.

* Read at the Annual Meeting of The American Academy of Orthopaedic Surgeons, Atlantic City, New Jersey, January 14, 1942.



FIG. 2

End result of spastic paralysis in which fusion of the metacarpals fixed the thumb away from the palm.

defect is lengthened to receive a spike on the bone insert. A minimal length of one centimeter is to be preferred.

3. The length of the cortical block from the anterolateral surface of the tibia must be gauged accurately by the distance between the bone recesses in the metacarpals, with the thumb held in extreme opposition. The corners of the cortical block are removed carefully by rongeurs and cutting forceps, leaving a keystone-shaped block with pegs for insertion.

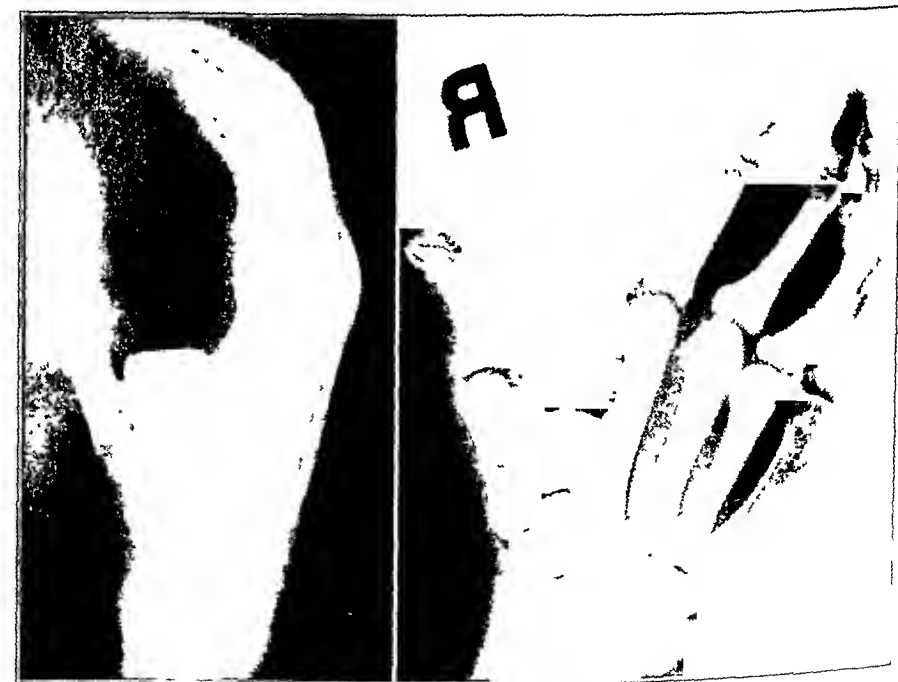


FIG. 3-A

Roentgenograms of recent intermetacarpal graft, and end result of same graft after five years.

2. Following subperiosteal exposure of the shafts of the metacarpals, the thumb is adducted to the limit of its mobility, and the adjacent surfaces of the metacarpals are marked by a small gouge. A drill is used to penetrate the volar cortex of the metacarpal of the index finger and the opposing cortex of the metacarpal of the thumb. This initial



FIG. 3-B
End result.

4. The tension of tissues in the interosseous space is sufficient to hold the locked graft firmly. The mid third of the space offers an ample bed for such a graft without intruding on the radial artery.

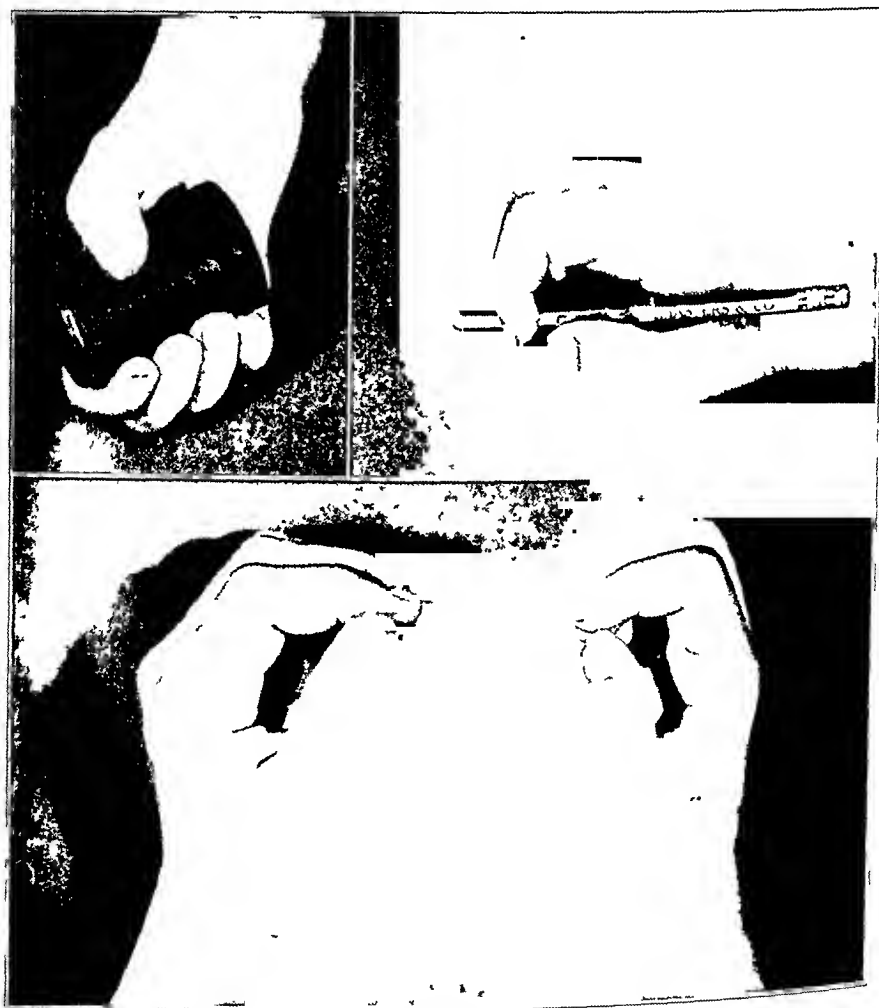
5. The wrist and metacarpals are fixed in plaster for twelve weeks, so as to permit active use of the fingers and thumb for grasping, and this fixation is prolonged thereafter as is indicated. Four months has been the maximum period of fixation in this series. The metacarpal of the thumb may be held opposite the palm by counterpressure over the fifth metacarpal, in the plaster dressing. Plaster should support the space between the index finger and the thumb.

Hands of children under the age of fourteen have been considered immature, and therefore subject to growth defect if fused in this manner.



FIG. 4-A

Laceration of the forearm at the age of four, and secondary tendon and nerve repair at the age of eleven.

FIG 4-B
End result.

In no instance has the metacarpal of the index finger rotated, allowing the thumb to resume its former displacement. In this series, there has been no trauma or fracture in the graft.

Observation of the healing of this type of bone graft, and subsequent restoration of grasping power between the thumb and fingers has reaffirmed the following principles of orthopaedic surgery:

1. A free bone graft and atrophied bone in which there has been retarded growth will undergo hypertrophy and accelerated growth in direct proportion to functional stress and stimulus.

2. Muscles of children and growing adults, which have been weakened by disuse for a period as long as twelve years, will regain power, if skeletal deformities are corrected and functional use is restored.

3. Fixed stability is preferable to unbalanced motion in certain types of impairment of rotation of the thumb.

This operation has been used in seven hands, the first of which was of a sixteen-year-old boy, who has remained under observation for a period of five years (Figs. 3-A and 3-B). The most recent case has been observed for nine months. Of these seven cases, one was a failure. A pseudarthrosis between the graft and the metacarpal of the thumb occurred. Fusion of the wrist for stabilization was done prior to fusion of the metacarpals. At the time of operation only slight flexion power in the index finger and thumb existed as a result of anterior poliomyelitis at the age of two years. In the other six cases, firm union between the graft and the metacarpals occurred. One of the latter was in the right hand of a girl of sixteen with a spastic hemiplegia in which motor-nerve section of the ulnar nerve at the wrist was followed by late contracture (Fig. 2). One of the good results was in the hand of a boy, fifteen years old, who at the age of four years sustained an extensive laceration of the right forearm which was complicated by infection (Figs. 4-A and 4-B). Both median and ulnar nerves were sectioned, and repair of the flexor tendons had been only partially successful.

This method of fusing the metacarpal of the opposed thumb to that of the index finger is to be recommended in carefully selected hands only. It remains as a final therapeutic measure where transplants are not available or have been inadequate in paralytic hands, and where thorough muscle reeducation and release or transfer of muscle tension has been inadequate in the hand affected by spastic paralysis; it utilizes the final remnant of grasping power between the thumb and finger or fingers in the traumatized hand, following adequate surgical repair of damaged tendons and nerves.

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CONTRIBUTORY CLINICAL OBSERVATIONS ON INFANTILE PARALYSIS AND THEIR THERAPEUTIC IMPLICATIONS *

BY A. STEINDLER, M.D., F.A.C.S., IOWA CITY, IOWA

From the State University of Iowa Hospitals, Iowa City

I. THE CONVENTIONAL PRINCIPLES

The challenge which confronts the conventional or, as it has been recently dubbed, the orthodox treatment of the acute and subacute stages of anterior poliomyelitis is directed principally against (1) uninterrupted immobilization, and (2) the exclusion of any and all mobilizing manoeuvres during that period.

In defense of the former principle, the old system contends that absolute rest does not cause atrophy of the muscles, that it is harmful to stimulate them in the early stage by muscle exercise, that the joints do not become rigid from immobilization, and that, on the other hand, the unopposed healthy muscle will lead to contracture unless the limb is continuously supported. In defense of the latter principle, it is claimed that motion is distinctly harmful to the paralyzed muscle; that it accentuates the paralytic state of a muscle to the point of total palsy because of easy exhaustion, and that the fatigability of the affected muscle is so great that many months are necessary to offset the bad effect of a single momentary indiscretion.

II. CLINICAL OBSERVATIONS

The question arises whether, in the face of this challenge, clinical and laboratory experiences actually warrant adherence to the old principle, or whether a change or a modification is justified.

A. *The Contractures.*

Are the paralytic contractures always due to the unopposed pull of non-paralyzed muscles, or do apparently paralyzed muscles contract?

From observations made in this Clinic within the last few years (by Sheplan, and others)† it has been found that contractures developed in patients who were splinted from the outset, as well as in untreated patients. These contractures were by no means always caused by the pull of the unopposed strong muscles. On the contrary, they were found frequently in muscles which were apparently severely paralyzed, particularly in the quadriceps and in the back muscles.

Two hundred cases from the Iowa epidemic of 1940 to 1941 were studied; most of them were admitted to the Hospital during the acute stage.†

* Read before the Annual Meeting of The American Orthopaedic Association, Baltimore, Maryland, June 5, 1942.

† See Annual Report of The National Foundation for Infantile Paralysis, Inc., 1941.

Contractures of some kind developed in apparently paralyzed muscles in approximately 25 per cent. In cases of quadriceps paralysis which were immobilized by continuous splinting, extension paralysis of this muscle invariably developed, and more so in apparently severely paralyzed muscles. Subsequent mobilization of the contracted joint proved very difficult in spite of long-continued physiotherapy. These contractures developed as early as three and one-half weeks after the onset of the paralysis, and as late as eight months. The contracted quadriceps, though incapable of active contraction, is hard and indurated, and, when an attempt is made to flex the knee, there is pain and tenderness over the muscle belly and not over the knee, showing that the resistance is in the muscle and not in the periarticular structures. Apparently this is not a fixation contracture, as seen after plaster immobilization of normal

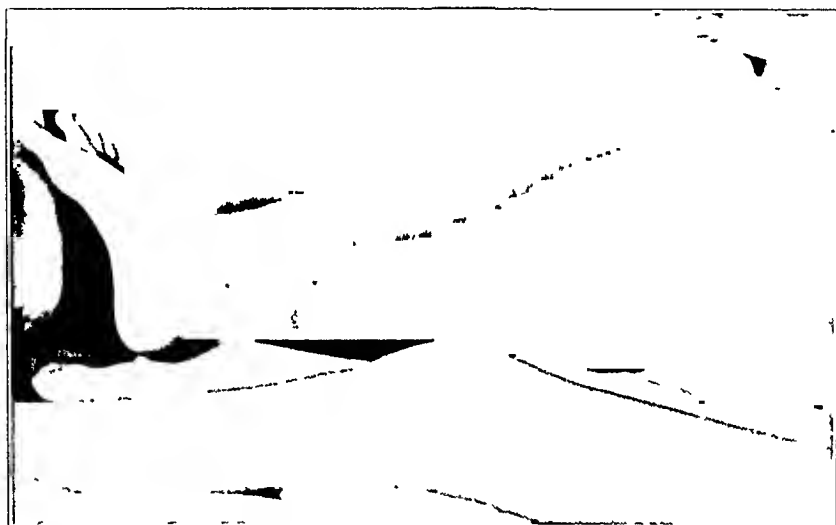


FIG. 1

Extension contracture of a completely paralyzed quadriceps.

muscles, because it develops so early under continuous splinting, and because it is so resistant to mobilization (Fig. 1).

True postural contractures may develop at the same time in non-paralyzed muscles. When the shoulder is placed in abduction for deltoid paralysis, there is a definite tendency to contracture of the trapezius, together with a contracture of the paralyzed deltoid, unless the splint is applied at considerably less than a right angle (Fig. 2).

In one-half of the patients, the trunk musculature was extensively involved. There was marked lordosis from paralysis of the abdominal muscles, but, when patients were placed in recumbency and traction, the lordosis promptly disappeared, and with it the abnormal tilt of the pelvis. Strangely enough, in this position an extension contracture of the lower back muscles frequently developed. This type of contracture was very resistant.

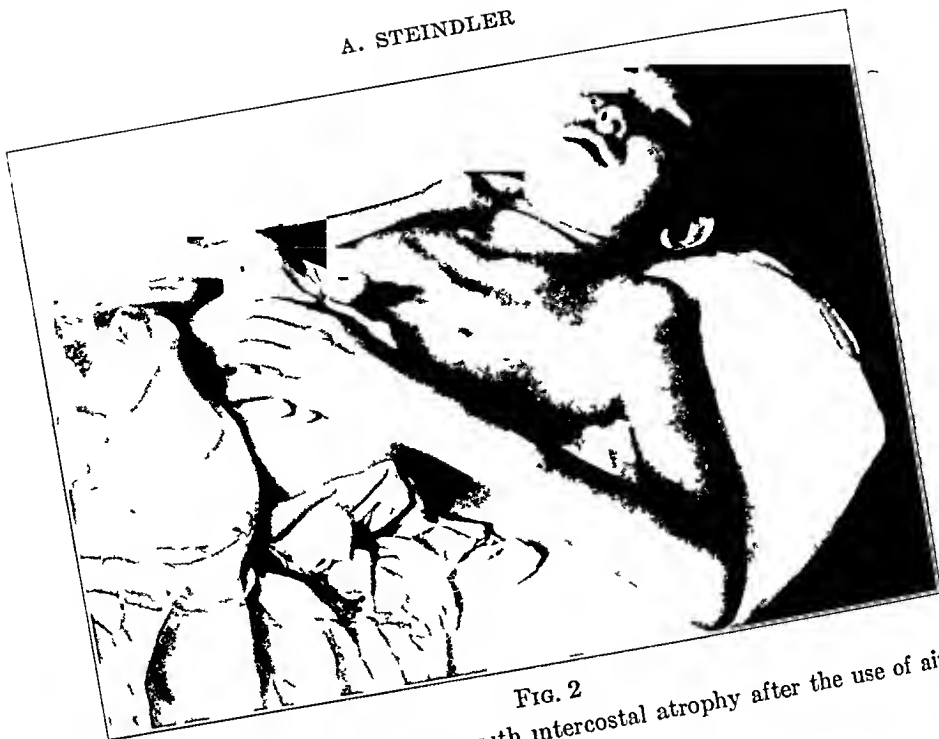


FIG. 2

Contracture of the trapezius with intercostal atrophy after the use of airplane splints.

B. Ligamentous Relaxation.

Ligamentous relaxation of the joint is observed independently of muscle involvement; some patients with paralysis of the deltoid show subluxation of the shoulder. A comparison with patients having peripheral paralysis of the axillary nerve shows the latter to have no such degree of disalignment.

It must be assumed that tendons, ligaments, and capsular rein-

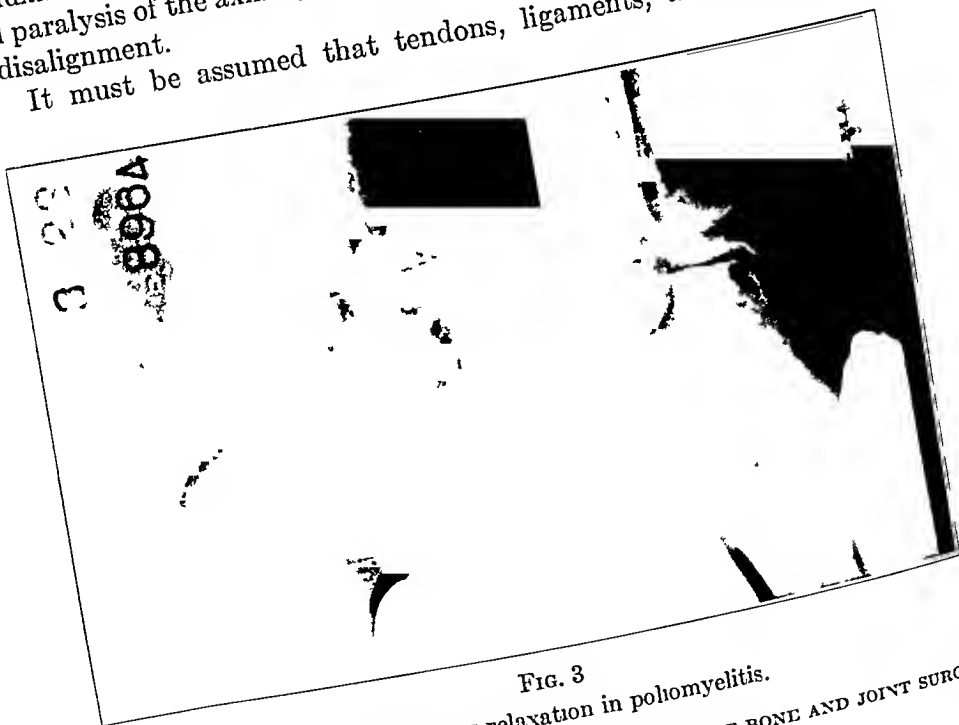


FIG. 3

Ligamentous relaxation in poliomyelitis.

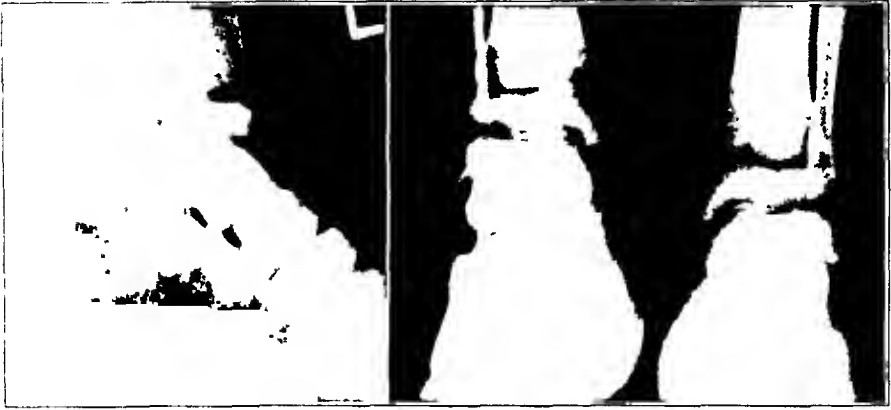


FIG. 4

Bands of supra-epiphyseal absorption, patchy sclerosis, and atrophy.

forcements are involved in pathological changes, as are the muscles (Fig. 3).

C. *Bone Atrophy.*

In the long bones of paralyzed extremities changes were observed consisting not merely in increased atrophic translucency and cortical thinning, but also in discrete transverse bands of absorption. That these bands were not disturbances of enchondral growth was evident in young adults with completely closed epiphyseal lines, where similar changes were found (Fig. 4). Also, it was found that the changes were most marked in patients with the more severe involvement of the surrounding musculature and in those who showed adjacent muscle contractures.

That lack of static function is not the determining factor in shortening was shown in a study of 160 cases. It appears that walking and weight-bearing played little, if any, part in the degree of ultimate shortening, as most of the shortening occurred long after resumption of the static functions of the limb, but age at onset and degree of paralysis were much more potent factors.

D. *Sympathetic Changes.*

Observations at this Clinic (made by Dr. L. A. Russin)* seem to indicate that the poliomyelitic limb is hyperhidrotic (Fig. 5), hypothermic, and hyperpilomotoric. Until recently there has been no definite evidence that the lateral horns, which supply the preganglionic fibers of the sympathetic outflow, are involved in poliomyelitis. From experimental investigations, made by Dr. V. Wolkin of our Staff, with pilocarpine tests on novocainized and non-novocainized sympathetic nerves of poliomyelitic limbs, there is, in fact, reason to believe that the cause of hyperhidrosis is peripheral and not central; it is probably due to circulatory stasis caused by lack of muscle tone.† As the situation stands, the fact is simply accepted that serious circulatory disturbances exist in some of the severely

* See Annual Report of The National Foundation for Infantile Paralysis, Inc., 1940.

† See Annual Report of The National Foundation for Infantile Paralysis, Inc., 1942.



Fig 5
Hypohidrotic legs in polymyositis shown by the starch-iodine-sweating test.

paralyzed patients, in contrast to others equally severely paralyzed who show little or no damage to the circulation.

III. FACTORS CONTROLLING PARALYTIC SCOLIOSIS

The fundamental concept in regard to the production of scoliosis is based on the premise that the spine normally is endowed with a powerful protective apparatus, essentially of a passive nature, which guards the spine against scoliotic deformation. This consists of the stabilizing effect of the thoracic cage through the vertebral anchorage of the ribs; of the orientation of the intervertebral articulations; of the physiological antero-posterior curves which lock the spine against both lateral deviation and rotation; and, finally, of the intrinsic elasticity of the ligamentous structures of the spine, the longitudinal ligaments, and the discs. This immense store of intrinsic tension and pressure stresses makes the spine into a rigid rod, even without the supporting action of the muscles. This is mentioned specifically to point out that paralytic scoliosis is not merely a case of simple muscle imbalance.

The following clinical observations on the development and course of paralytic scoliosis were made principally by Dr. Farkas of our Staff.

In the majority of cases it requires from four to five years for full development. This means there is a phase of "unsettled" deformity, which is most valuable for prophylactic measures.

The direct muscle imbalance (the pull of a healthy muscle against a paralyzed opponent) seems inadequate to explain the scoliosis. A definite pathological condition, aside from muscle involvement, must be assumed,—a condition which interferes with or destroys the passive intrinsic equilibrium. Muscle imbalance cannot explain the translatory shift,—because this presumes some "give" of the ligamentous structures as well as of the intervertebral discs (Fig. 6).

A. *The Rôle of Pelvic and Thoracic Rotation in Producing Paralytic Scoliosis.*

It has been observed that the longitudinal rotation which always precedes lateral deviation is characteristic of the paralytic scoliosis.

1. *Pelvic Rotation.* The pelvis is the most potent factor in spinal rotation; though the rotation is counteracted principally by the system of intervertebral discs. Contracture of the hip, uneven position in bed, asymmetry of gait, equinus, *et cetera*, can bring about an asymmetrical rotary effect of the pelvis, and is therefore of great prognostic importance. This pelvic rotation is transmitted into the entire lumbar and lower thoracic spine in the same direction, and results, in the great majority of cases, in a final long thoracolumbar or total curve. It has been observed (by Dr. Farkas) that for a long period the lateral curves following rotation are concave rotation curves, but this is a temporary stage; the final curve is always convexly rotated.

2. *Thoracic Rotation.* Thoracic rotation is another essential factor.

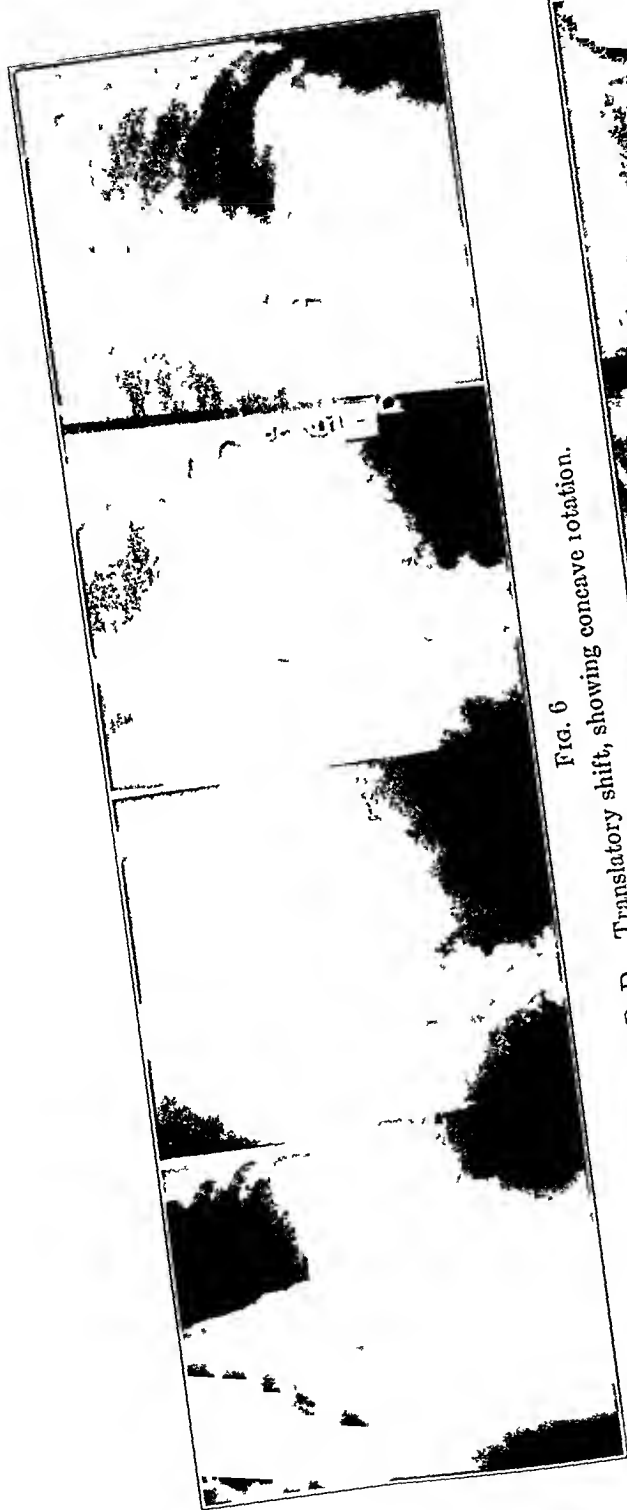


Fig. 6

B. D.

Transitory shift, showing concave rotation.

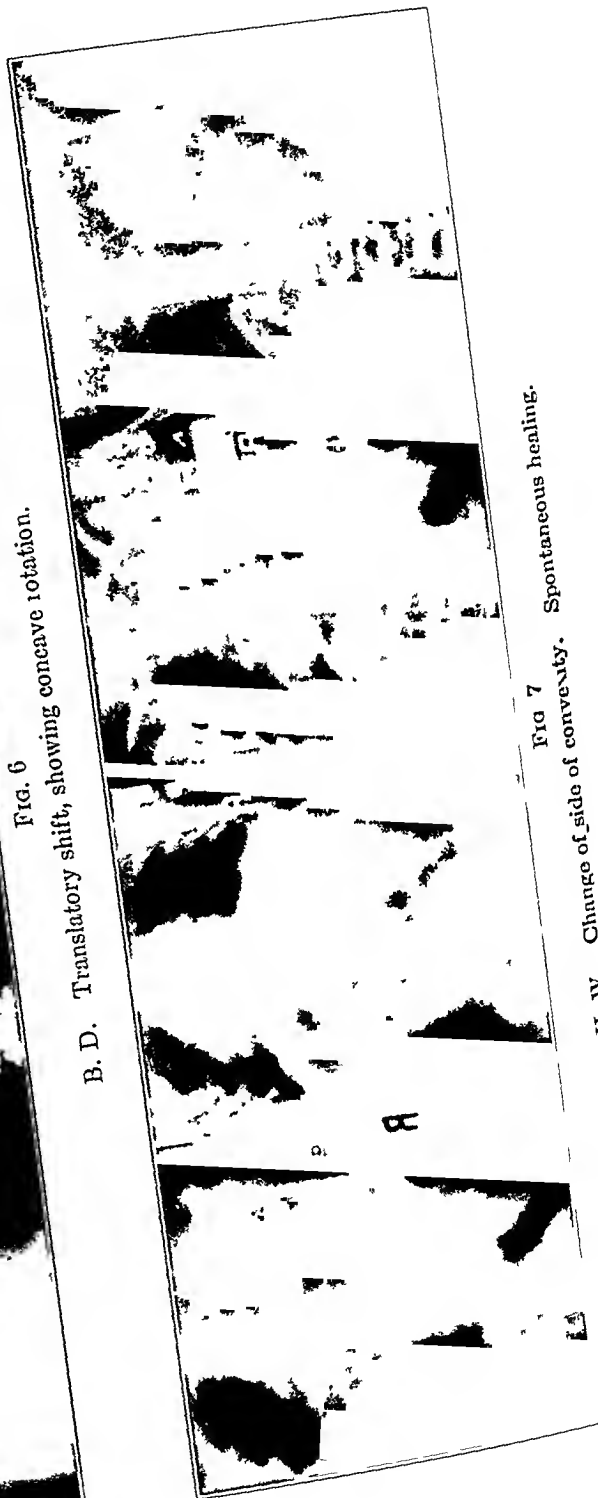


Fig. 7

H. W.

Change of side of convexity.

Spontaneous healing.

If the physiological effect of respiration upon the spine is affected, low vital capacity is the result, and the diaphragm stands high. The intervertebral disc, together with other ligamentous structures, maintains the integrity of the thoracic spine, and with it the respiratory function. Failing in this, a disalignment between the thorax and spine occurs as the natural safeguards break down,—hence the translatory penetration of the spine into the thorax, and the development of a lateral curve. It follows that preservation of respiratory function from the start is essential.

In this connection respiratory rigidity or spasm may be mentioned. Twelve patients had definite respiratory paralysis, necessitating the use of a respirator. Contracture (or spasm) of the paralyzed intercostals was noted in several cases, and considerable effort by the physiotherapist was necessary to restore normal ability of the ribs to flare outward and to expand in normal inspiratory excursion. Later, breathing exercises were of great value.

The "breakdown" of the spine, outside of muscle imbalance, may thus be due to the relaxation and instability of the skeletoligamentous system, as evidenced by the bone atrophy extending all over the spine; by the early ossification of ring epiphyses, even at the age of four (normally this occurs in girls at eleven, and in boys at thirteen); by the narrowing of intervertebral discs (Schmorl's pearls); by their greater compressibility; and by calcium deposits.

All these make possible translatory shifts of the vertebrae, the unilateral disc compression, and the early vertebral rotation; and all these changes are reversible in their early stages (Fig. 7).

The increased anteroposterior flexibility of the spine and the increased lordosis may also disappear with the recovery of the ligament-disc apparatus, except when abdominal muscles are involved.

B. The Rôle of Muscle Involvement in Producing Paralytic Scoliosis.

On the other hand, without muscle involvement, paralytic curves do not develop, even though additional involvement of the ligament-disc apparatus is present.

It is not possible to establish a correlation between involvement of individual back muscles and scoliosis, but it can be said that:

1. No case of pelvic rotation was seen without asymmetric involvement of the lower extremities.
2. In most cases of thoracic rotation, there was involvement of shoulder muscles or serious disturbance of respiration.
3. Two types of contractures leading to scoliosis were seen,—contracture of the lateral abdominal muscles and of the sacrospinalis, with pelvic obliquity and lumbar curve; and contracture of the respiratory type with rotation of the thorax and thoracic curve.

The immediate cause of rotation is then the pathological muscle imbalance between the two sides of the body; the more remote cause is the decreased resistance against rotation from damage to discs and ligaments.

IV. THERAPEUTIC IMPLICATIONS

The therapeutic implications of these findings for the acute and sub-acute stages of infantile paralysis can now be stated briefly.

As has been pointed out, the motor loss from involvement of the anterior-horn cell is the principal, but by no means the only, pathological feature of infantile paralysis, and the treatment plan is necessarily influenced by the additional clinical factors of pain, muscle spasm, and contractures due to spasms, and substitutionary and mass movements.

Pain, spasm, and spasmodic contractures arise from proprioceptive

stimuli. For the first two the author has fully accepted Miss Kenny's splendid technique of hot packs, and for the latter, he favors early motion. Splints or sand bags are used where they offer protection against pain or serve to prevent fatigue,—that is, intermittently. The factor of muscle spasm was observed to be an impediment to the return of muscle function. In those cases in which the muscle spasm and contractures could be easily overcome, the gain in muscle power was more easily accomplished. For the treatment of substitutionary or mass movements, Miss Kenny's excellent technique of individual muscle training and selective muscle ex-



FIG. 8

Mass movements (substitution), reeducated with hot packs and training

ercises has also been adopted (Fig. 8). These succeeded particularly in reestablishing the function of the deltoid and tibialis anterior. In one of the cases treated by hot packs and muscle reeducation only, the tibialis anterior, which had started at zero, improved to a classification of good. The remainder of the muscles which showed improvement started out as fair or better and progressed to good. In other cases it was observed

that, although no definite muscle improvement could be noted in any particular muscle, the function of an extremity, and in some cases the gait, was definitely improved because of the elimination of incoordination and mass movements (substitutionary movements) by muscle reeducation. The author is, however, going to continue the use of braces in ambulatory patients where the static functions of standing or walking demand it, and especially since it is necessary to protect the relaxed periarticular structures of the knee and ankle.

In the specific situation of paralytic scoliosis, there is a rather long period between the onset and the final settlement of the scoliotic curve, and there is ample opportunity for prophylaxis and early treatment.

First of all, recumbency is imposed on the patient for a matter of several months wherever there is reason to believe that a paralytic scoliotic curve is developing. To this is added a regimen of high-vitamin diet and physiotherapy. Respiratory capacity is tested by proper measurement, and is improved by respiratory exercises. The pelvis is derotated in recumbency by proper positioning of the patient. The position of the diaphragm and the flare of the ribs, as well as the outlines of the intervertebral discs, are noted in the roentgenogram as they improve under treatment. The pelvic thoracolumbar curves can be seen to improve as the rotation is controlled.

After the age of sixteen, the prognosis of paralytic scoliosis is favorable, except for the cases in which the patients are kept in a constant sitting position.

Patients are encouraged to start walking on crutches or by help of a tripod for nearly all the time they are out of bed. Sitting is prevented as much as possible. After the period of recumbency, the general and local treatment is continued as before, and the trunk is held by a support.

It should be understood that the author is referring to the paralytic scoliosis in the stage of development only; this entire plan of treatment reaches its limit the moment the curves are "fixed". Then the ligamentous structures and discs are "set", and the changes are no longer reversible. From here on the principle of restoring posture by compensation methods is still held; and only in case the latter fails to produce permanent compensation and restoration of posture are operative procedures indicated.

Likewise, it should be understood that the practice of physiotherapy and muscle education refers only to the treatment of the acute and subacute stages of infantile paralysis in general. Improvement in both muscle strength and selective action has been noticed up to two years after the onset of paralysis. Weaker muscles may gain strength after that time, but no "zero" muscle was noted to recover after more than two years.

The permanent deformities and disabilities which are found in the chronic stage, of both the extremities and the trunk, are in no way affected by these changes in the conventional treatment, except in so far as their frequency and the degree of ultimate deformities are influenced by it.

A SPLINT FOR FRACTURE OF THE CARPAL NAVICULAR

BY ERIC L. FARQUHARSON, M.D., F.R.C.S. (ED.), EDINBURGH, SCOTLAND

In fracture of the carpal navicular (scaphoid), treatment is long, but the life of a plaster cast is short. As the period of immobilization may extend into several months, the patient is often compelled, by economic or other necessity, to return to light work during treatment—indeed he is rightly encouraged to do so. The effective life of the plaster cast, however, is inversely proportional to the strains placed upon it. The part of the cast covering the forearm and hand may remain firm, but any plaster in the palm is liable to become softened or cracked by contact with objects held in the hand, and, if even light manual work is to be carried out, its destruction is only a matter of time. Furthermore, it is impossible to keep the palmar portion of the cast completely dry. When the fingers are being washed, a certain amount of splashing is inevitable, and sweating of the palm has a similar deleterious effect. Even in the case of fractures which heal in the minimum time of six to eight weeks, it is usual for two casts to be required. In fractures requiring immobilization for several months, a succession of plaster casts must be applied.

It is the opinion of Watson-Jones that "every single movement of the wrist joint puts back the process of repair by several days. It is the neglected plaster which causes delayed union and non-union". However, the term "neglected" may be applied to many of the casts which are replaced. The patient is, of course, instructed to report back to the surgeon without delay, if the cast becomes loose or broken; but it is difficult to make him understand the degree of fixation required; and he is usually content to believe that the cast is satisfactory as long as the greater part of it is firm. Furthermore, if he lives at some little distance from a hospital, it may be difficult for him to have his cast renewed as soon as he suspects that it is becoming soft. All too frequently, therefore, he returns wearing a plaster, which, for several days or longer, has been giving inadequate support. Moreover, it is rare for the surgeon to renew a cast which still appears to be firm and tight-fitting; he usually waits until there is some sign of softening. By this time, a little movement is taking place at the wrist joint, and again the cast must be described as "neglected". During the removal of a cast, further movement at the wrist joint is inevitable, with consequent retrogression in the healing process.

It is to avoid such interruptions in the continuity of immobilization that a special splint has been devised. This consists of a framework to which is attached an adjustable band for encircling the hand. The framework, which is made of light metal, is applied to the dorsum of the forearm and hand. It is incorporated in a plaster cast which extends only as far as the level of the wrist joint. The encircling band is made of soft aluminum, and is easily molded around the hand by digital pressure. It is adjustable by means of a bolt, which can be turned with a small coin.

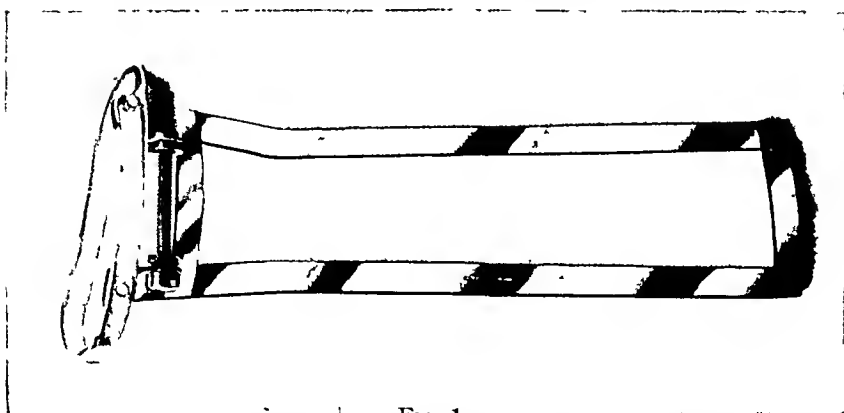


FIG. 1

Special splint for the treatment of fracture of the carpal navicular. (*Reproduced by courtesy of E. & S. Livingstone.*)

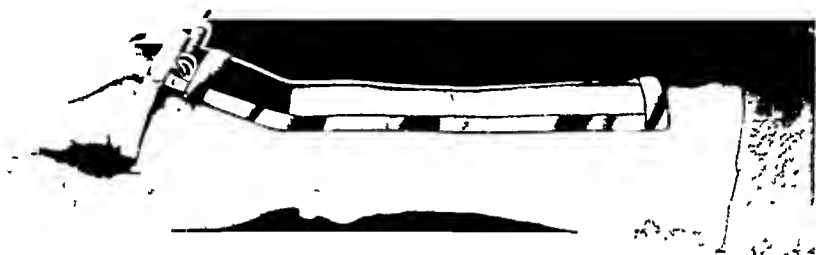


FIG. 2

Application of splint. The framework of the splint is shaped to fit the plaster cast so that it lies comfortably and evenly against the back of the hand in the required position of dorsiflexion. It is then incorporated in the cast. The aluminium band lies proximal to the palmar creases, so that movements of the fingers are unrestricted. (*Reproduced by courtesy of E. & S. Livingstone.*)

The standard splint, as supplied by the manufacturers, is designed so that the circumference of the band may be varied between eight and nine and one-quarter inches,—that is, it will fit the hand of most adult male patients. Other sizes must be especially ordered. The framework is shaped to hold the hand in moderate dorsiflexion, but, being of soft metal, it can be bent easily with a spanner to suit individual requirements.

The splint, together with the method of application, is shown in Figures 1 and 2. A light plaster cast, composed of one four-inch bandage and extending down to the level of the wrist joint, is first applied. The framework of the splint is bent so that it lies *comfortably and evenly* against the skin of the back of the hand in the required position of dorsiflexion, and it should also be shaped so that it lies closely against the surface of the plaster cast (Fig. 2). It is then incorporated in the cast with a second plaster bandage. Finally, the aluminium band is molded by digital compression to the contours of the hand, and is tightened by means of the bolt. If careful attention is paid to the molding of the splint, and if the patient's cooperation in indicating areas of pressure is secured, absolute fixation of the wrist joint can be obtained without any discomfort to the patient. The band lies proximal to the transverse creases of the palm, so that flexion of the fingers is unrestricted. The patient is instructed that the band should be kept as tight as can be comfortably borne. The circumference of the hand may vary considerably with the temperature of the surroundings, and adjustments should be made accordingly.

The splint provides no immobilization of the first metacarpal bone, but whether or not this is absolutely necessary is open to question. Movements of the first metacarpal may reduce to a slight extent the degree of immobilization at the site of fracture, but there is little evidence to suggest that this is a factor of any great importance in the healing process. The main cause of delayed union is to be found in the shearing strains to which the fracture is subjected by even slight movements at the wrist joint. The splint immobilizes this joint most effectively, and, in the cases where it has been employed, progressive union has taken place.

The splint lasts indefinitely, and the plaster cast which secures it to the forearm should not require renewal for several months. If the patient will cooperate in adjusting the aluminium band to suit the variations in size of the hand caused by temperature changes, more complete immobilization can be obtained. When carefully applied, the splint is no more uncomfortable than a plaster cast; it interferes less with active use of the hand, and the fact that the plaster does not extend below the wrist allows the hand to be washed as usual. The framework of the splint does not interfere with roentgenographic examination of the fracture.

The author has also used this splint with success in a recent case of delayed union of a fractured carpal navicular in which a bone-grafting operation was necessary. By means of this splint, the patient was able to return to his normal duties three and one-half weeks after operation, and union was firm five months later.

CONGENITAL UNILATERAL ABSENCE OF THE PECTORAL MUSCLES OFTEN ASSOCIATED WITH SYNDACTYLISM

BY EBER RESNICK, M.D., LOS ANGELES, CALIFORNIA

*From the Children's Hospital, Los Angeles **

The most frequently encountered muscle anomaly in humans is a unilateral congenital absence of the pectoral muscles. In 1902, Bing¹ reviewed the literature completely, and found that absence of the pectoral muscles occurred approximately six times more frequently than any other anomaly of the muscle system.

There have been numerous reports of associated deformities in patients with an absence of the pectoral muscles. The only deformity found in the present short series was a congenital syndactylism of the fingers, varying in degree, and present on the same side of the body as the muscle anomaly. The three patients who presented syndactylism showed a shortened forearm as well as shortened fingers,—probably as a result of a disuse atrophy.

Mention has frequently been made of a degenerative lesion of the central nervous system—usually an aplasia of the brain—which is frequently associated with syndactylism, but the four patients reported were perfectly normal mentally.

Roentgenograms of the chest were made in all cases, and no bone deformity was reported.

CASE 1. (See Figures 1-A and 1-B.) M. C., aged three years, showed a deformity of the right chest, which had been noticed since birth. The mother had been told that it was due to a birth injury.

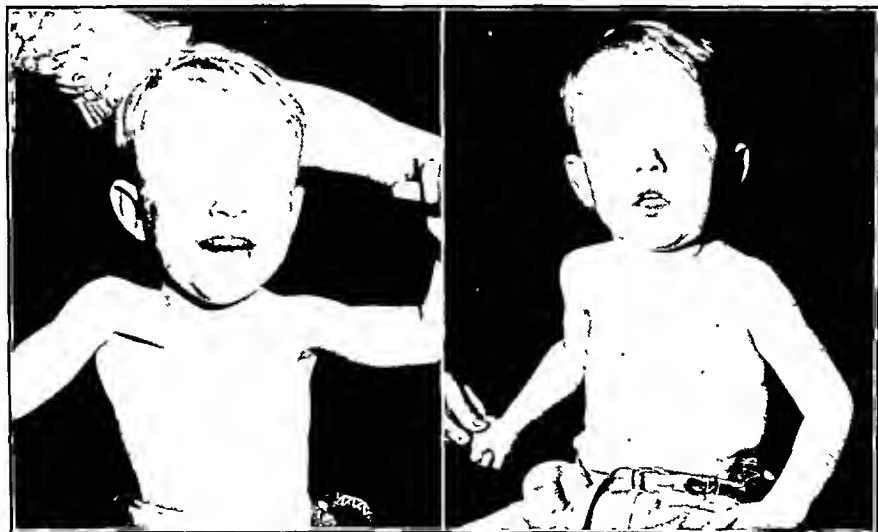


FIG. 1-A

FIG. 1-B

* Orthopaedic Service of John C. Wilson, M.D.

Physical examination revealed a markedly flattened right chest. Motions of the shoulder were normal but on flexion of the right humerus with slight external rotation, a thin band of tissue, apparently the fibrosed remnant of the clavicular head of the pectoralis major, stood out very prominently. The asymmetry of the chest was quite marked. There was no evidence of syndactylism. The forearm and finger lengths were equal.

CASE 2. (See Figures 2-A and 2-B.) R. B., three and one-half years old, was brought to the Hospital for a deformity of the left chest with webbing of the fingers.



FIG. 2-A

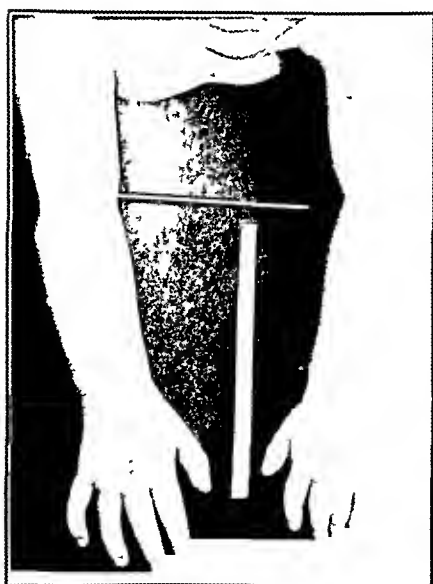


FIG. 2-B



FIG. 3-A

Physical examination revealed asymmetry of the chest with loss of subcutaneous tissue over the left breast region, and a somewhat depressed thoracic cage on the left. The pectoralis major and pectoralis minor were absent on the left. There was webbing



FIG. 3-B

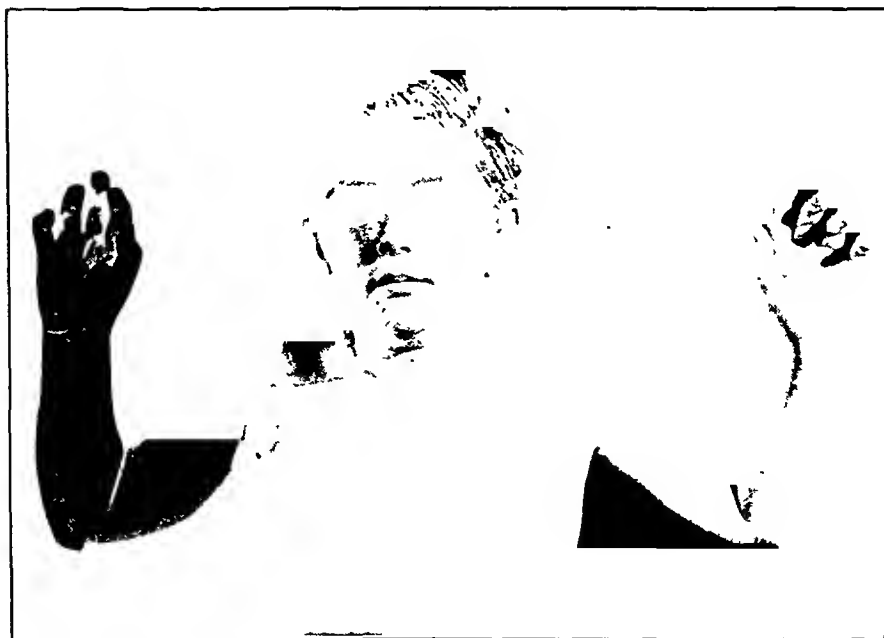


FIG. 4-A

of the index and middle fingers to the proximal interphalangeal joint, and of the middle and ring fingers to the distal phalangeal joint. The left forearm was two and five-tenths centimeters shorter than the right, and the left hand and fingers were smaller.

CASE 3. (See Figures 3-A and 3-B.) T. S., aged three years, had a flattening of the right chest with webbing of the fingers of the right hand.

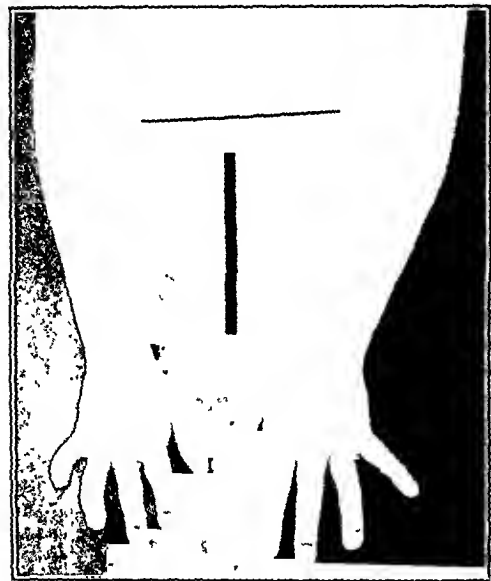


FIG. 4-B

Physical examination revealed an absence of the pectoral muscles on the right. The right forearm was three centimeters shorter than the left, and the right hand was smaller. A webbing was present between the index and middle fingers of the right hand extending to the distal phalangeal joint.

CASE 4. (See Figures 4-A and 4-B.) L. D., aged twelve years, complained of flattening of the right side of the chest which had been noticed since birth.

Physical examination revealed an absence of the pectoral muscles on the right. The right forearm was four centimeters shorter than the left. Syndactylism of the right hand had been repaired surgically, and a good functional result had been obtained. It had involved the middle, the index, and the two small

fingers up to the distal phalangeal joints. The right hand was small and the fingers were shorter than those of the left.

The function of the shoulder joint was not impaired in any of the patients, and normal motion was present.

1. BING, ROBERT: Ueber angeborene Muskeldefekte. *Virchows Arch. f. path. Anat. u. Physiol.*, CLXX, 175, 1902.

A METHOD FOR COMPLETE REMOVAL OF THE SEMILUNAR CARTILAGE

BY KNOX DUNLAP, M.D., F.A.C.S., CAMP BARKELEY, TEXAS

*Lt.-Colonel, Medical Corps, United States Army, Medical Replacement Training Center,
Camp Barkeley*

*From the Orthopaedic Section, Station Hospital, Schofield Barracks,
Territory of Hawaii*

During the author's service at Schofield Barracks he had the opportunity to see an unusually large number of injuries as a result of the stress laid upon athletic activities at that station. He was particularly impressed by the large number of knee injuries among the soldiers, and by the number of days of duty lost because of these injuries. The greatest number of internal derangements of the knee occurred during the football and boxing seasons, and many of these included damage to the semilunar cartilage. In reading the literature and in attempting to find some means of simplifying the operation for the removal of the semilunar cartilage, he found the description of the Lowe-Breck cartilage knife published in *The Journal of Bone and Joint Surgery*.¹ A knife that was a modification of

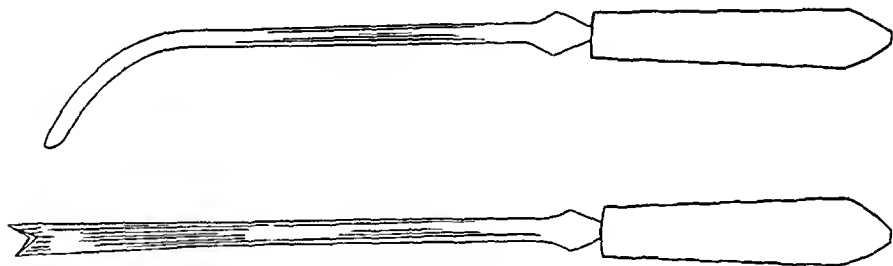


FIG. 1
Modified Lowe-Breck knife.

the Lowe-Breck instrument was made. It appeared that this new knife was simpler in construction and worked just as well. (See Figure 1.)

The Jones incision gave the best exposure of the anterior one-third of the semilunar cartilage, and by freeing the anterior one-third, using a small scalpel, and grasping it with strong forceps for traction, the curved knife was easily slipped around the outer margin of the cartilage, separating it from its attachments with the exception of the very posterior internal segment. The traction forceps was then moved backward to about the mid-position of the cartilage. By a gentle pull on the forceps with one hand, and slight flexion and extension of the leg on the thigh with the other, the cartilage was dislocated into the intercondylar notch. The remaining attachment could then be easily and completely

removed by the use of a turbinate knife, the left turbinate knife being used for the lateral cartilage and the right for the internal cartilage. The

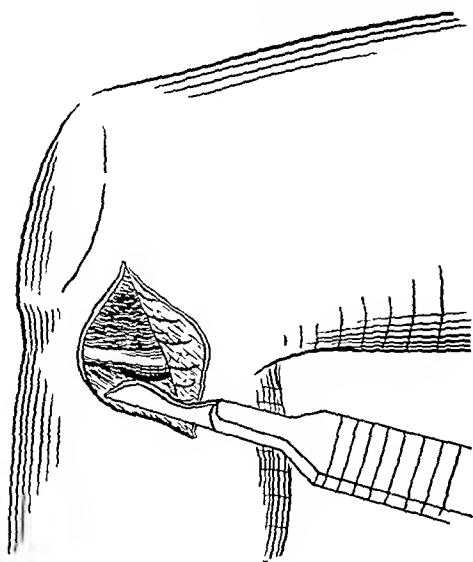


FIG. 2

Anterior horn is freed with a small scalpel.

blade of the turbinate knife was passed posteriorly and inferiorly to the cartilage which remained in the grasp of the forceps, and through the intercondylar notch, until the blade was well back of the posterior attachment. Taking a firm grip on the knife, and with a slight rotary and forward motion, the cartilage was removed. Care must be taken not to hook the knife back of the cruciate ligaments and sever them.

About fifty patients have been operated upon using this method, and all of them were returned to duty in from two to

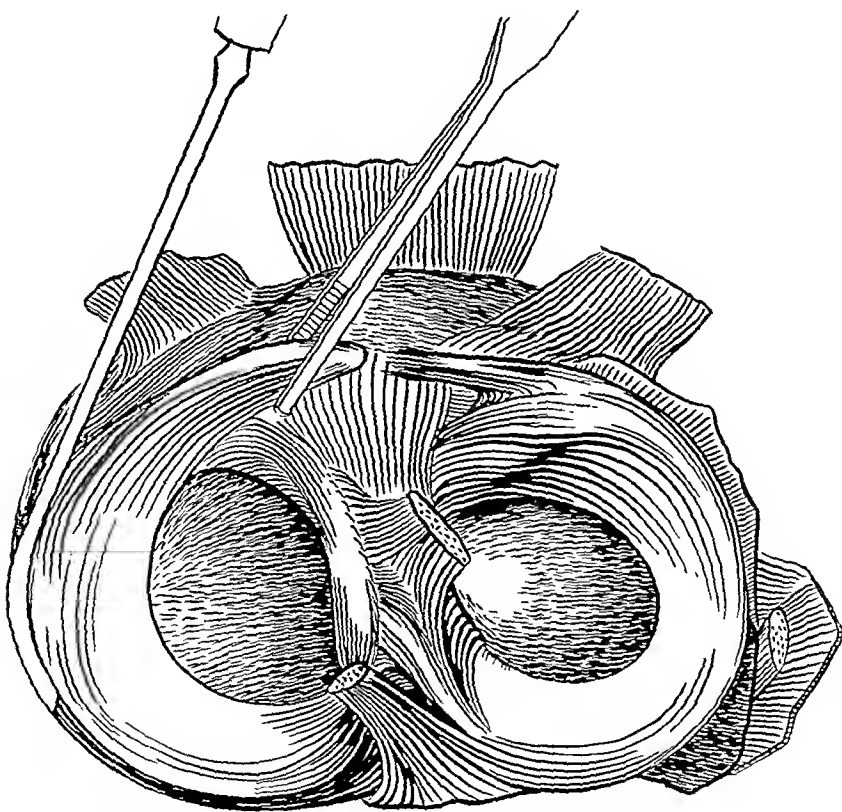


FIG. 3

Curved knife is slipped around the outer margin of the cartilage.

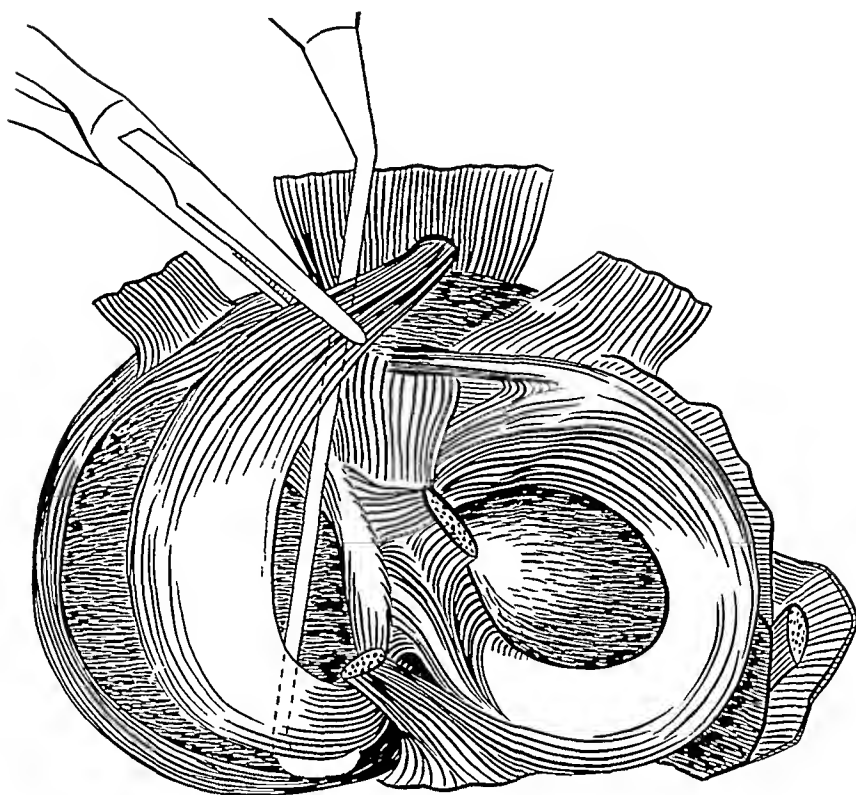


FIG. 4

Cartilage is dislocated into the intercondylar notch. The posterior segment is excised by the use of the turbinate knife.

three weeks. All had complete function restored, and were performing full military duty. It is believed that by using this method the cartilage in its entirety can be removed. The posterior one-third will not be left, as is the case in many instances, and injury to the articular cartilage by the remaining fragments and free margins will be avoided. The smallest amount of damage possible is done to adjacent structures by the use of the curved, turbinate, and operating knives. No injury at all is done to the articular cartilage, as there was formerly when curved scissors were used. These instruments can easily be obtained in any operating room.

This procedure, it is believed, definitely shortens the convalescence by minimizing the residual symptoms, which are thought to be largely the result of trauma incurred during the operation.

The drawings for the illustrations of this paper were made by the Art Department, Medical Replacement Training Center, Camp Barkeley, Texas.

1. LOWE, F. A., and BRECK, L. W.: A New Knife for Use in Removing Semilunar Cartilages. *J. Bone and Joint Surg.*, XX, 220, Jan. 1938.

NON-UNION OF THREE RIBS

BY DARRELL G. LEAVITT, M.D., SEATTLE, WASHINGTON

Non-union or pseudarthrosis of the ribs following fracture is comparatively infrequent and has received little or no attention in the textbooks. Although the author has seen previous instances, he has not observed any case in which there was non-union of more than one rib; and it has been his impression that non-union of the so-called floating ribs is more common.

In the following case, a dense adhesive process on the posterior

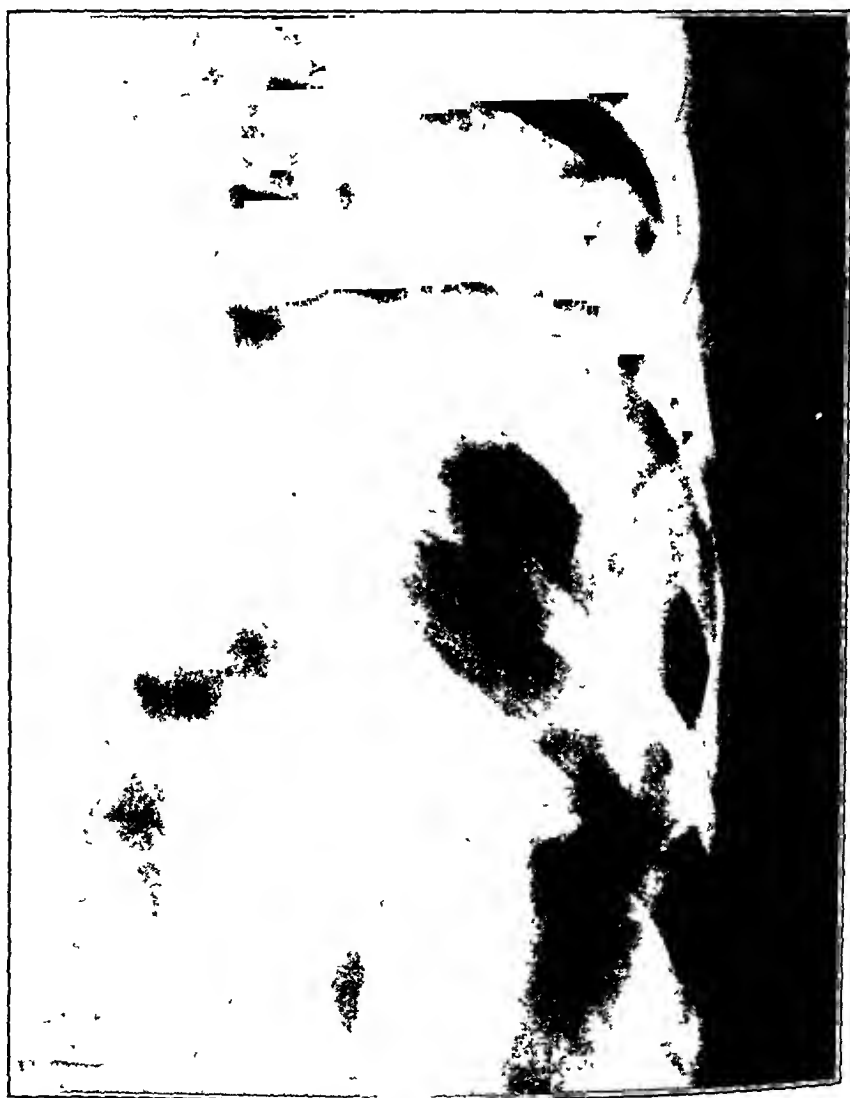


FIG. 1

July 29, 1938. Ununited fractures of the eighth, ninth, and tenth ribs and questionable non-union of the seventh rib.

portion of the diaphragm, demonstrated in an oblique roentgenogram, no doubt produced abnormal excursion of the proximal fragments of the fractures, thus producing an unusual mechanical basis for instability, and preventing union.

CASE REPORT

A man, fifty-three years of age, was seen on July 29, 1938, complaining of discomfort in the left side of the chest and occasional expectoration of blood.

On September 29, 1937, he had injured the left thorax in a severe fall. Adhesive strapping was applied to the chest, and the patient was kept in bed for three weeks. Removal of the strapping was followed by considerable pain in the left side of the thorax, and the patient coughed up blood. There was marked swelling of the left thorax, extending to the base of the neck, which persisted for several weeks.

Examination of the thorax by the author revealed marked impairment of percussion resonance over the posterior lower third, extending to the lateral aspect. There was absence of breath sounds over the area of percussion dullness. A small amount of sugar was found in the urine. Subsequent fasting blood-sugar studies revealed persistent slight elevation only. Consultation with Dr. Byron Francis disclosed an adhesive process between the posterior quadrant of the left diaphragm and the thoracic wall with a mild bronchiectasis.

Roentgenographic examination (Fig. 1) revealed non-union of the eighth, ninth, and tenth ribs with questionable non-union of the seventh rib. Other roentgenograms demonstrated fractures of a number of adjacent ribs, but these were thought to be healed and united in good alignment.

On October 10, 1938, about one year after the injury, an operation on the left thorax was performed. A long, straight incision was made over the posterolateral thorax, splitting the fibers of the latissimus dorsi in their longitudinal direction. The sites of non-union were then exposed by transverse incision over each rib in its longitudinal direction. This necessitated separating the digitations of the serratus posterior inferior and the periosteum at the ends of the ribs near the sites of non-union. With each expiration and inspiration, marked excursion (from one-half to three-quarters of an inch) was found to exist between the ends of the ununited ribs. There was non-union of the eighth, ninth, and tenth ribs, but the seventh rib was found to be solidly united.

Several methods of producing solid union were considered, but, because of the width of the gap revealed in the roentgenograms, it was decided that a bony bridge should be created. Therefore, three cortical grafts were removed from the right tibia,—each three inches in length and about one-half an inch in width. These were made in the shape of a shuttle. The ribs, having been left mainly covered by periosteum, especially

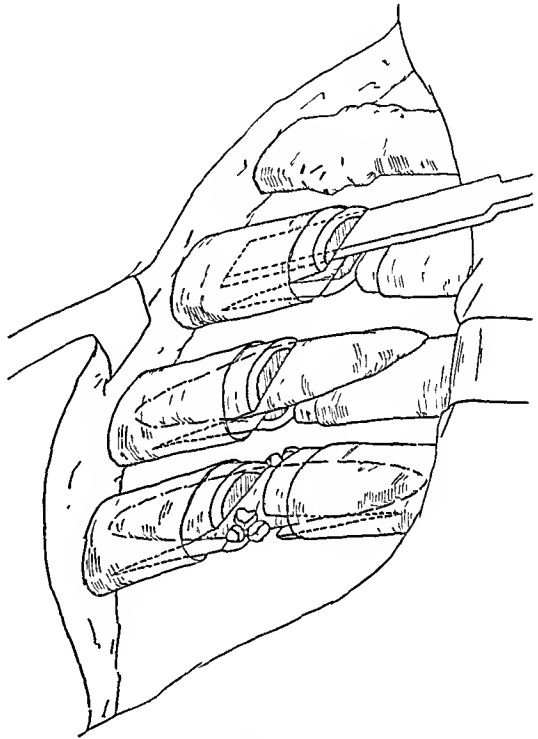


FIG. 2

Diagrammatic sketch of operative procedure.

NON-UNION OF THREE RIBS

BY DARRELL G. LEAVITT, M.D., SEATTLE, WASHINGTON

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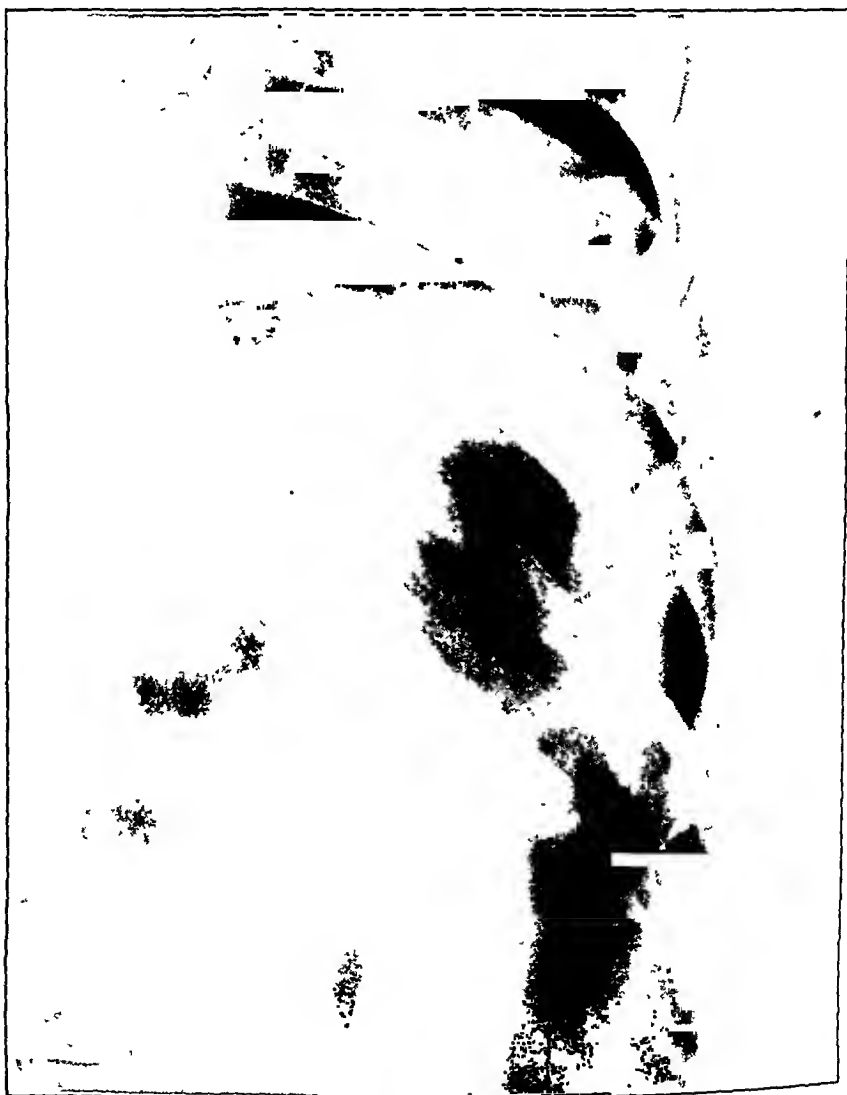


FIG. 1

July 29, 1938. Ununited fractures of the eighth, ninth, and tenth ribs and questionable non-union of the seventh rib.



FIG. 4

January 24, 1941. Solid union of all three ribs. Stainless-steel suture *in situ*.

About this time a prominence appeared in the chest over one end of this graft, which was painful on pressure. There was also increased complaint of local discomfort in the chest at this time.

On November 25, 1939, a second operation was performed, in which the three fractured ribs were exposed as before. The eighth rib had become solidly united. In the case of the ninth rib the graft had united solidly to one of the fracture fragments, but a very narrow stable pseudarthrosis existed between the graft and the other fragment; the graft was still in excellent position, but was sliding slightly in the smooth reciprocal surface of the rib. The graft in the tenth rib was solidly united to the distal fragment and appeared to be viable; but the other end protruded into the soft tissues, having eroded its way out of the proximal fragment. The pseudarthrosis in the ninth rib was freshened. The bone, however, was left in its bed. Cancellous bone from the shaft of the rib away from the fracture site was taken off with an osteotome and placed about the freshened site of non-union. A wire loop was placed about the protruding graft in the tenth rib to hold it closely approximated to the proximal fragment. Here, again, cancellous bone was removed from the rib at a greater distance and packed around this pseudarthrosis.

The trunk was encased in plaster with very little padding, the plaster remaining in place for twelve weeks.

Roentgenographic examination (Fig. 4) on January 24, 1941, showed solid union of all three ribs, with the stainless-steel wire still *in situ*.

This patient was an Industrial Accident case, and the degree of persisting discomfort was difficult to determine. However, he admitted that there had been a great deal of improvement in the pain in the left chest.

SUMMARY AND CONCLUSIONS

Non-union in rib fractures is not common. The case presented suggests that it requires an unusual circumstance, such as the occurrence of dense adhesions between one portion of the chest wall and the adjacent fragments, to produce sufficient excursion of the fragments to result in non-union. In this case tibial bone grafts assisted in securing union, although two operations were required to obtain union of all three fractures. A plaster cast about the trunk is probably advisable after this type of surgery to assist in securing some restriction of trunk, if not thoracic, motion.

LOCAL APPLICATION OF SULFONAMIDES TO SYNOVIAL SURFACES

BY EDGAR M. BICK, F.A.C.S., MAJOR, MEDICAL CORPS, UNITED STATES ARMY,
AND HOMER C. PHEASANT, CAPTAIN, MEDICAL CORPS, UNITED STATES ARMY,
FORT MONMOUTH, RED BANK, NEW JERSEY

From the Station Hospital, Fort Monmouth

The efficiency with which topical application of sulfonamide derivatives prevents infection in clean traumatic or operative wounds can no longer be questioned. Favorable results in controlling gross infection have been reported and fully confirmed by many investigators. However, investigations of the special activities of these agents, when applied to various tissues, must continue, so that their proper relationship to standard surgical procedures can be ascertained, and their secondary effect on these tissues can be studied.

For the past year, the effect of the sulfonamides, when applied locally, on the process of wound healing and the reaction of the cutaneous and subcutaneous strata to them have been studied on this Service. In reporting upon this study,¹ it was shown that the application of sulfonamides directly to wound surfaces, in the quantities and by the methods which had been recommended by various writers, delayed healing by 50 to 75 per cent. of the anticipated time factor, in both operative and traumatic wounds. Because of this pronounced lag in healing time with high drug concentrations in the superficial tissues, the sulfonamides have more recently been applied by the authors only to the deep tissues of wounds, and have been deliberately kept away from skin surfaces and immediate subdermal areas. In the present series of cases, the amount of sulfonamide topically applied was less than one-half the quantity initially used. This plan of applying the drugs to the deep levels only led to a study of the reaction of synovial surfaces to direct contact with these agents.

In the course of 140 operations on or about joints or tendon sheaths, sulfanilamide was applied directly to synovial tissue in fifty-six cases. Sulfathiazole was used in an additional twenty cases. The remaining sixty-four cases, of comparable range and variety of operations, did not have any sulfonamides administered topically.

The drug was applied to articular synovial tissues in forty-six of the seventy-six cases in which one of the sulfonamides was used, and to synovial tissue of bursa or tendon sheath in thirty cases. These wounds were carefully observed for evidence of any alteration in healing, and more particularly, for evidence of prolonged or residual dysfunction as compared with the rapidity of healing and recovery of function in similar operative wounds not treated with these drugs. One specific group of cases within the larger group, in which such comparison was possible

to a considerable degree of accuracy, was represented by arthrotomies of the knee joint for fracture of a meniscus or osteochondritic lesions. An almost identical Jones, or crescentic, incision was used, of approximately the same length and location in twenty-nine such cases. One of the sulfonamides (usually five grams of the drug), was implanted directly in the knee joint in fifteen cases. This group was compared with a group of fourteen cases of knee arthrotomy in which no sulfonamide was used. As in the general series, no variation in postoperative function or any other alteration in tissue reaction was found, in comparing the two groups, which might have been attributed to the effect of sulfonamide drugs on synovial tissues. In certain of the earlier cases, the additional application of the drug to the superficial tissue layers had impaired and prolonged wound healing, and there was a corresponding lag in complete mobilization of the part. In the present series, follow-up at successive weeks and close comparison of muscle strength, range of motion, and synovial reaction in the treated and untreated knees indicated that no discernible ill effect had resulted from the application of the smaller quantities of sulfonamides to the synovial surfaces of the knee joint. Protection from infection was, moreover, equally effective when these smaller doses were used and superficial cutaneous areas were avoided.

When applied to certain tendon sheaths, such as those of the extensor and flexor tendons at the wrist or fingers, which are relatively closer to the skin surface, wound healing was characterized by persistent swelling and induration at the site of the topically applied sulfonamide, which would recede slowly over a period of from ten days to two weeks. This was evidence of more than normal postoperative tissue reaction, but was not painful. Function in the eighteen patients in whom this reaction was noted compared favorably at the end of one month with a comparable number of patients in the group in whom no drug was used. In the latter part of the series, when the smaller doses were well buried in the deeper layers, healing was more rapid and the degree of induration considerably less.

The question of adequate dosage in local application of the sulfonamide derivative in any area of the body has not yet been determined. It is certain that in the first trials the drugs were used in unnecessarily large amounts. Many surgeons no longer pack the wounds with the drug. Spraying or otherwise completely covering the exposed surfaces of a wound or incision is, according to the authors' experience, equally unnecessary. With smaller doses of these drugs, there is less proliferation of subcutaneous fibrous elements, and wound healing more closely approximates that of primary union in wounds not exposed to the local sulfonamides. This is particularly important around articular or tendon-sheath areas where large amounts of the drug, in retarding superficial wound healing, prevent the active motion necessary to insure proper function of the restored synovial surfaces.

In comparable Jones incisions, the amount of sulfonamide has varied from ten grams to three grams, introduced well within the joint cavity.

There have been no infections and no residual functional differences except, as remarked above, that the larger doses tended to delay wound healing. In most cases, five grams were implanted in the knee joint. Amounts ranging from ten to five grams of the drugs have been placed about and within the tendon sheath of the long head of the biceps brachialis in tenodesis operations at the shoulder. Here, too, the smaller doses have been equally effective. For a wound on the finger, from five-tenths to one gram has been found sufficient to prevent infection and to permit early union without undue fibrosis, and still not to interfere with normal recovery of tendon function.

No differences in the effect of sulfanilamide or sulfathiazole could be found as to susceptibility to infection, joint or tendon-sheath reaction, the rate of wound healing, or the functional result. Both were completely effective in preventing infection. At present, the authors are using only sulfanilamide, because it is easier to handle. Moreover, due to its slower solubility, this drug maintains its local effect for a longer period of time. This observation must not be interpreted as applying to the use of the drugs by mouth. The respective indications when used by mouth are reasonably specific.² Apparently with the local-tissue concentrations attained by topical applications, the bactericidal effect of either drug is sufficient to prevent infection. Furthermore, the dosage and relative toxicity of the drugs, when given by mouth, require consideration of the harmful general reactions which do not occur when dealing with topical applications of the quantities used on synovial surfaces.

CONCLUSIONS

1. Topical application of sulfonamide derivatives to the deep tissues in traumatic wounds or surgical incisions, avoiding the skin and the immediate subcutaneous areas, have been just as effective in preventing infection as when sprayed or otherwise spread over the entire wound area. This has been specifically observed in applications to the articular, tendon-sheath, and bursal-synovial tissue.

2. In general, far smaller doses than are usually recommended have been found adequate, and do not significantly retard healing.

3. Sulfonamide derivatives can be applied safely to synovial tissues of joint cavities and bursae or tendon sheaths. When reasonably small quantities are used, no residual adhesions, fibrosis, or other alterations occur, which are not found in similar lesions treated without these drugs.

4. In topical applications to joints or other synovial surfaces, sulfanilamide and sulfathiazole are entirely effective, and can be used interchangeably. Sulfanilamide, because of its smoother handling and greater local staying power, is recommended as the sulfonamide of choice.

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A CASE OF XANTHOMA OF THE KNEE JOINT

BY D. H. O'DONOGHUE, M.D., OKLAHOMA CITY, OKLAHOMA

In 1939, DeSanto and Wilson¹ reported an excellent series of xanthomatous tumors of the knee joint, in which they listed thirty-two cases from the literature, and added nine cases of their own. This is a report of one more case. DeSanto and Wilson commented that no case had been diagnosed preoperatively, and the author regrets to say that his case proved to be no exception.

Mrs. M. L., aged thirty-four, white, was examined on May 11, 1940, at which time she reported that two months before, she had attempted to push a buffet drawer shut with her knee. The foot was turned out and as she was pushing inward with her knee, she felt severe pain in her knee, not localized. There was no swelling, and the pain decreased, so that in a day or so, the knee was practically free from pain. Two or three weeks later, she began to feel something slipping in the knee and at intervals, the knee would catch, so that she could not extend it beyond about 150 degrees. She would then twist it around to get it back in place. This happened many times, without any particular swelling of the knee. Two nights before she was examined, she had acute pain in the knee, and was unable to walk on the leg. Hot packs gave some relief. On examination, there was moderate swelling of the knee, no effusion, and tenderness in the line of the joint, medial to the patella. External rotation of the flexed leg caused pain at the anterior insertion of the medial meniscus. Abduction of the flexed knee caused no complaint, nor did adduction or internal rotation. There was no instability of the knee. There was slight tenderness over the anterior end of the medial meniscus. Roentgenographic examination was negative. The diagnosis at this time was fracture of the medial meniscus, and was based largely upon the history of the type of injury which had been followed by repeated episodes of locking. Operation was advised, and carried out June 4, 1940.

Operation: The usual small curved incision was made; the capsule was opened; and a moderate amount of distinctly yellowish, cloudy fluid was drained out. This was definitely more yellow than normal. The medial portion of the fat pad was found to be markedly congested and inflamed. The fat had a more yellow appearance than normal. There were adhesions running from the fat pad back to the intercondylar notch of the tennur. Both the adhesions and the area of their attachment showed marked congestion. There was, also, a marked localized synovial irritation. In the medial portion of the joint there was a tumor, one inch by three-quarters by one-half inch, which had a very small, apparently synovial pedicle, one-half inch long, extending down and attached to the fat pad adjacent to the synovial membrane. This attachment was at the anteromedial aspect of the tibia, at the level of the medial border of the patellar tendon. The tumor was excised, and the pedicle tied off. A considerable portion of the fat pad was removed, because of inflammation and redundancy. This portion included the adhesions which passed back to the intercondylar notch. The menisci were explored and found to be entirely normal. There was slight synovial irritation of the rest of the joint, but this was not marked, the reaction appearing to be localized largely around the area adjacent to the tumor. The usual closure was carried out, and a cotton cast and adhesive strips were applied. The tumor which had been removed was examined and found to be very fibrotic; on cutting through it, there were large yellowish areas scattered through an apparently fibrotic tumor mass. Due to the yellow character of the fluid and the yellow areas through the tumor itself, a postoperative diagnosis of xanthoma was made.

Postoperative Course: The patient was placed in bed with four pounds of traction and

a cotton cast for pressure. At the end of six days, the wound was entirely clean, the adhesive strips were removed, the traction left off, and the cotton cast reapplied. She wore this another five days. Fourteen days after operation, she had range of motion of 90 degrees without pain, and twenty-eight days after operation, there was normal range of motion with no pain or effusion. She was advised to wear an elastic bandage, and progress has been entirely satisfactory. She has been under constant observation since that time; in the first few weeks, she had a sensation of sticking or catching in the joint, although she never had any actual locking. With the exception of one instance, in April 1941 when she had some pain following a minor sprain, the knee has been in excellent condition. Examination of the knee on May 22, 1942, revealed a normal appearing knee: the scar was well healed; and there was a normal range of motion, no instability, and no tenderness. There was a moderate degree of crepitation of both knees, which did not appear to be worse in the one which had been operated upon. Her recent history has been entirely negative, and there is no evidence of any recurrence.

Pathological Report: "The gross specimen consists of: (1) an ovoid pinkish-gray, encapsulated, semifirm tumor, 20 by 10 millimeters. The cut surface is perpendicular, grayish-yellow, and firm; and, (2) an irregular ragged piece of tissue, which is of fatty consistency, 30 by 10 millimeters. Microscopic examination, June 11, 1940, shows a tumor composed predominately of pink-staining, dense, hyaline-type stroma; and bundles, groups, and streams of small oat-shaped cells. Internuclear material predominates throughout and some areas contain small tumor-type giant cells. An occasional, poorly circumscribed area is xanthomatous. Microscopic diagnosis: Benign synovioma with xanthomatous degeneration. This is in keeping with the so-called xanthoma of the synovium."—H. Jeter.

In this case of xanthoma of the knee, the tumor was solitary, pedunculated, and well delineated. The patient had an unusually prompt recovery following operation, and apparently, at the present time, has a normal knee. She has been advised of the possibility of recurrence and will be observed for any such development. The author wishes to emphasize, again, the extreme similarity of the symptoms of these discrete tumors to those of rupture of the medial meniscus.



FIG. 1

Xanthoma of the knee, (longitudinal section).

1. DESANTO, D. A., AND WILSON, P. D.: Xanthomatous Tumors of Joints. *J. Bone and Joint Surg.*, XXI. 531, July 1939.

ACUTE OSTEOMYELITIS OF THE PATELLA

A CASE REPORT

BY HENRY T. KIRBY-SMITH, M.D., SEWANEE, TENNESSEE

From the Emerald-Hodgson Hospital, Sewanee

Osteomyelitis of the patella is an unusual condition; only sixty cases have been reported. The literature on the subject consists largely of the reports of isolated cases, inasmuch as in only a few instances has one man had the opportunity of treating more than a single case. The condition is sufficiently rare to justify offering one other case for record.

The patient, a white boy, seven years old, the son of a farmer, was first seen on June 2, 1939. According to the history, on May 12, an infected area had appeared on the right ankle; it had gradually spread and had become more painful. After a week the foot and ankle were red and swollen, and there was a tender mass in the right groin. On May 21, the left knee had become swollen, red, and so painful that the patient had been unable to walk. A slight improvement had occurred during the next twelve days, but the patient was still unable to walk when first examined.

Examination showed a thin, pale boy who did not appear to be acutely ill. The temperature was 99 degrees, and there was evidence of a subsiding infection on the right ankle. The left knee was red and swollen, and although motion was painful, the patient

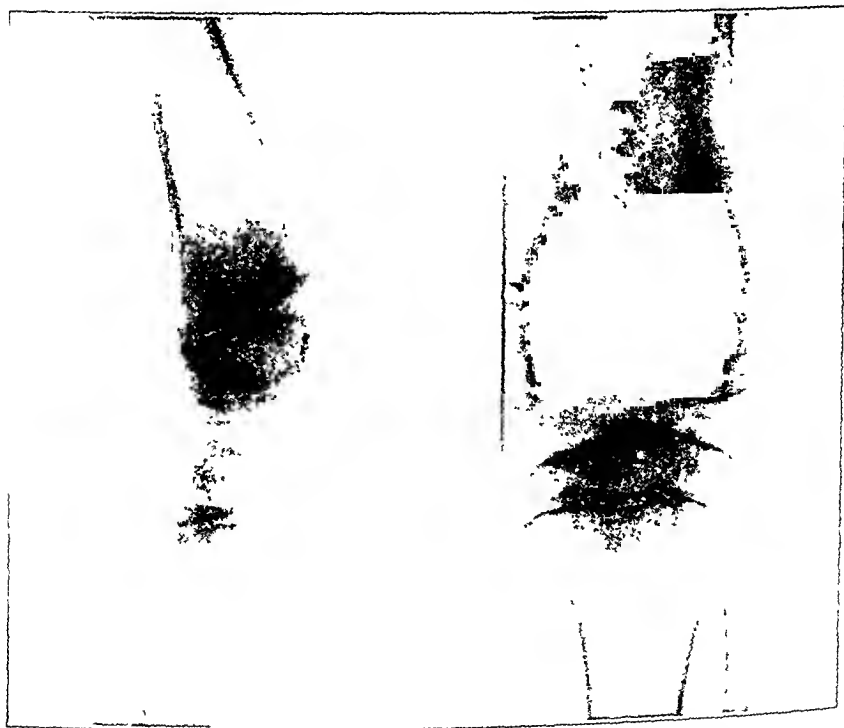


FIG. 1-A

FIG. 1-B

June 29, 1939. Roentgenogram of the patella taken forty days after the onset of the infection, showing the moth-eaten appearance.

was able to flex and extend the knee to a slight degree. An enlarged lymph gland was felt in the left groin. The knee joint was aspirated and ten cubic centimeters of turbid fluid was obtained. No organisms were discovered in a stained smear of the joint fluid.

A diagnosis of acute arthritis of the knee joint was made at this time. Treatment consisted of rest in bed and the administering of sulfanilamide. Ten cubic centimeters of fluid from the joint again failed to show organisms.

On June 10, a red, semi-fluctuant area was noted over the patella. On June 12, under local anaesthesia, an incision was made, and pus was obtained. Smears of the pus showed staphylococci in large numbers. The wound continued to drain for seventeen days, and, because of the prolonged drainage, roentgenograms (Figs. 1-A and 1-B) were made on June 29 which revealed a moth-eaten, fragmented patella. A diagnosis of osteomyelitis of the patella was made, and operation was advised.

On July 10, under ether anaesthesia, the wound was enlarged transversely. It was found that the patella had disintegrated into three pieces which were lying free and unattached in a cavity lined with granulation tissue. The pieces were removed from the cavity. Gentle exploration of the cavity resulted in breaking through the posterior wall into the knee joint. From this opening a thick, mucuslike fluid escaped. The opening in the patella bed was enlarged, and rubber-tissue drains were inserted through the opening and brought out through the stab wounds, on either side of the knee joint anteriorly. Following the operation, drainage continued.

At the end of two weeks the drains were removed. Drainage gradually subsided, and on August 13, 1939, the wound had completely healed. At this time the swelling had somewhat diminished and motion had improved.

The patient was seen every three to four months, and when last seen in October 1941, almost complete function had returned to the joint, there being approximately 5 degrees of limitation of extension. There was no pain resulting from active



FIG. 2-A

FIG. 2-B

September 13, 1939. Roentgenogram of the knee sixty-five days after operation, showing the absence of the patella.

or passive motion. Roentgenograms showed bony regeneration of the patella, although it was larger than normal and very irregular in shape. Palpation revealed a large flat, rubbery mass in the region of the patella, which felt like cartilage and which measured two and three-eighths inches by two inches, in contrast to the measurements of one and three-quarters inches by one and three-quarters inches of the normal patella of the right knee.



FIG. 3-A

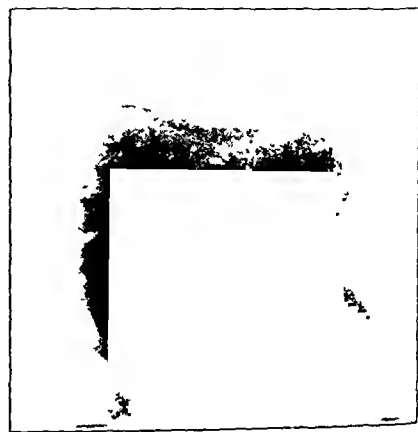


FIG. 3-B

May 31, 1940. Roentgenograms, taken ten and one-half months after operation, show the regenerated patella which is very irregular in outline.

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News Notes

The Annual Meeting of **The American Academy of Orthopaedic Surgeons** is scheduled to be held at the Palmer House, Chicago, January 17 to 21, 1943.

The 1942 Clinical Congress of the **American College of Surgeons**, originally scheduled for October at the Stevens Hotel, Chicago, which has been taken over by the United States Army Air Corps, will be held in Cleveland, November 17 to 20. Headquarters will be at the Cleveland Public Auditorium. The Hospital Standardization Conference, sponsored by the College, will be held simultaneously.

Colonel Norman T. Kirk has been relieved from duty as Chief of the Surgical Service at Walter Reed General Hospital, Washington, D. C., and ordered to command the Percy Jones General Hospital, Battle Creek, Michigan.

Dr. Harold A. Sofield, of 715 Lake Street, Oak Park, Illinois, announces the association with him of Dr. Manley A. Page in the practice of orthopaedic surgery.

Dr. Paul C. Colonna, who has been Director of the Department of Orthopaedic Surgery at the University of Oklahoma School of Medicine for the past four years, has been appointed Chief of the Department of Orthopaedic Surgery at the Hospital of the University of Pennsylvania, and Professor of Orthopaedic Surgery in the Medical School. He entered upon his duties in Philadelphia on August 1.

The Fifth Annual Congress of the **Sociedade Brasileira de Ortopedia e Traumatologia** was held June 30 to July 3, 1942, at Rio de Janeiro. Two of the important subjects for discussion were Obstetrical Paralysis, and Internal Derangement of the Knee. One session was devoted to War Traumatology, and various officials of the Army, the Navy, and the Department of Aeronautics participated. An interesting feature of the meeting was the exhibition of surgical instruments and orthopaedic apparatus which was held in the Hall of the National Academy of Medicine.

An appeal to those interested in poliomyelitis is made by Dr. H. C. Elliott of the Department of Anatomy, University of Toronto, Toronto, Canada. Under a grant from the United States National Research Council, research is being carried on which requires complete spinal cords of acute cases where death has occurred from the disease itself, and, even more particularly, of chronic cases in which death has resulted from other causes some time after paralysis. A promising line of attack is being seriously hampered by lack of material. Cords from acute and particularly from chronic cases are required. Even a single cord would be of great value.

Specifications call for intact cords or intact upper or lower halves. The dura should be left on, but may be slit up the back. The cord may be cut into three equal lengths. Fixation should be straight, preferably with 2-per-cent. glacial acetic acid in 95-per-cent. alcohol, but may be with formol saline; about a pint of the solution should be used. Up to \$10.00 can be provided for technical assistance in removing a cord. Sections required for use of donor will be prepared, if desired, as cord must be intact on receipt.

The Commonwealth Fund of New York, a philanthropic foundation established in 1918 by the late Mrs. Stephen V. Harkness, announces that it is offering through the **Pan American Sanitary Bureau** fifteen fellowships for one year's study of public health subjects or postgraduate medical courses to properly qualified persons who are citizens of the other American republics. Fellowships in public health will be open to

physicians, sanitary officers, technicians, public health nurses, etc. Each fellowship will provide living allowances while the holder is in the United States, travel costs, and tuition. Knowledge of the English language will be among the requirements, and also the possession of certain specific qualifications.

Application blanks giving complete information will be available through the Commonwealth Fund, 41 East 57th Street, New York; the Pan American Sanitary Bureau, Washington, D. C.; or chiefs of the American Missions in Latin America.

Readers of *The Journal* are invited to contribute material to the Treasury of Science. This new series of low-priced, pocket-sized books is designed to serve the student and the reading public interested in the sciences and ready to devote intelligent effort to their understanding. The books will be introductory volumes to their subjects. The Board of Editors includes Prof. Harlow Shapley, of Harvard University; Dr. Alvin Johnson, Director of the New School for Social Research; and Dr. Alfred E. Cohn, of the Rockefeller Institute. Correspondence about manuscripts should be addressed to the Treasury of Science, L. B. Fischer Publishing Corp., 381 Fourth Avenue, New York, N. Y.

Word has just been received of the death of Dr. Charles Hope Jaeger, of Greenwich, Connecticut, on September 12. Dr. Jaeger was for many years consultant in orthopaedic surgery at the Lenox Hill Hospital, New York City. His work on congenital dislocation of the hip is well known. Dr. Jaeger was an Emeritus Member of The American Orthopaedic Association.

THE BRITISH ORTHOPAEDIC ASSOCIATION

The Spring Meeting of The British Orthopaedic Association was held in Liverpool, May 29 and 30, under the presidency of Mr. G. R. Girdlestone, of Oxford.

In the discussion of the subject "The Delayed Union of Fractures", most of the speakers remarked on the generally held impression that delay in union is more common than formerly. Many of them mentioned the difficulties of the statistical approach, both in deciding upon a standard of "union" in the consideration of the time factor, and in comparing fractures of the same bone due to different types of violence. There was agreement in stressing the evils of late reduction, of distraction, and of infection.

Mr. George Perkins, Roehampton, differentiated between "union" when the fracture was solid, and "consolidation" when it had progressed to the state of ability to withstand normal stresses. He emphasized the importance of restoration of function and the need for muscle activity from the outset of treatment. He was convinced that fractures take longer to repair than they did and that there is something wrong with present-day treatment. He felt that prolonged rigid immobilization of fractures has been over-emphasized, with undue attention to distraction at the expense of the compression stress exerted on fracture surfaces by muscle action.

Mr. R. Watson-Jones, Liverpool, and Squadron-Leader W. D. Coltart, R.A.F., presented a detailed analysis of 500 shaft fractures of the femur and tibia treated in Royal Air Force Orthopaedic Units. They felt that the factors responsible for delay in the union of these fractures had been: (a) infection, which trebled the union time; (b) distraction of the fragments by excessive skeletal traction, which caused very marked indolence of the fracture surfaces and doubled the union time; (c) delayed reduction, late remanipulation, and, in the case of the femur, late bowing or refracture, which almost doubled the union time. In the absence of these delaying influences, fractures united firmly enough for the removal of splints and plaster in an average time of fourteen weeks. Union, as shown by clinical tests, had often been present earlier than this, but immobilization had been continued in walking plasters until consolidation could be proved by roentgenogram. The early resumption of weight-bearing in a walking plaster was a delaying factor in cases where minor angulation remained, as it tended to increase the

angulation momentarily and thereby distract the fractured surfaces on the open side of the fracture.

If it was recognized that union had been delayed by infection, distraction, late remanipulation, etc., and the period of plaster immobilization had been extended accordingly, these factors were responsible only for slow union and not for non-union. In this series of cases, where complete and uninterrupted immobilization had been maintained, there was not a single instance of established non-union. In eight cases, early bone-grafting had been performed to accelerate the rate of repair, but in the whole series there was not one single case of sclerosis of the fractured surfaces and established non-union, despite a high proportion of grossly contaminated and infected fractures. Ten per cent. of the patients were invalided; 90 per cent. returned to duty.

Mr. B. H. Burns, London, believed that the advantage of the more accurate anatomical position maintained in the modern unpadded plaster cast was possibly counterbalanced by the longer time that appeared to be taken in reaching union. Well-planned open reduction in selected cases offered perfect anatomical restoration, with greater freedom of the soft parts, earlier weight-bearing, and early union.

Dr. E. Harlan Wilson, Columbus, Ohio, was of the opinion that the type of initial violence might account for the greater time taken for recovery from motorcycle injuries, where speed of impact was noteworthy. He believed that damage to the vascular supply of bone had great bearing on the time of healing. He remarked on the frequency of delayed union in cases of multiple fractures with their greater demands upon the body's osteogenetic functions. In his experience with the Roger Anderson method of treatment he found it subject to the same conditions and time of fracture healing as other methods.

Major A. W. M. White, R.C.A.M.C., Toronto, Canada, believed that the factors most likely to affect the rate of union are the apposition of the fracture surfaces and complete and continuous immobilization. In 120 cases of fracture of the tibia, of which he had made a survey, reduction was considered adequate when roentgenograms showed that 75 per cent. of the fracture surfaces were in apposition. In fifty-one well reduced and immobilized leg fractures, the average time for union was four and a quarter months, whereas in thirteen inadequately reduced or poorly immobilized cases it was eight and a quarter months. Bone-grafting had resulted in union in 96 per cent. of the cases, but rehabilitation seemed to take longer than in the cases of union without grafting.

Mr. D. L. Griffiths, Manchester, made a determined plea for inquiry by statistical methods. He had submitted 249 cases of fracture of both bones of the leg, with displacement, to such inquiry. His conclusions were that open fractures heal more slowly than closed fractures, the two forming distinct groups, and that direct violence, severe violence, and inadequate apposition of the fragments are all delaying factors. Figures indicate that only the grosser errors of treatment are important in delaying union.

Mr. F. W. Holdsworth, Sheffield, reported from a study of 399 cases of fracture of the leg, treated throughout by his own team, that 349 returned to their former occupations and thirty-five to modified work. Only fifteen had very poor function. In 303 adults, 102 compound fractures united in an average of sixteen and one-half weeks (the longest period, twenty-eight weeks, was required in four cases), and the remaining closed fractures united in an average of thirteen weeks. He stressed concentration on end results rather than on the time taken to reach them. Continuity of treatment by one unit was an essential requirement. He and other speakers deprecated the late reduction occasioned by the slow movement of patients from one hospital to another.

Dietetic factors were discussed by Mr. R. I. Stirling, Edinburgh, with particular reference to the important part played by vitamin C.

On the second day of the meeting, a discussion was held on "Amputations", based upon the different views held by surgeons in Canada and in Great Britain. The former attitude was stated by Dr. LeMesurier, of Toronto. The preference of Canadian surgeons for end-bearing stumps for leg amputations was founded upon the results, and upon the superiority of stumps of this type as compared with those depending upon lateral bearing in the socket of an artificial limb. The speaker's remarks dealt more particu-

larly with Syme's amputation, which he was surprised to find so universally condemned in Great Britain. Although he had heard about the defective circulation in a Syme's stump, he had seen very little of it. On the contrary, he had found that the skin of such a stump was much more satisfactory for weight-bearing than was that upon the sides of the tibial condyles. He felt that a great deal of the success of the Syme's amputation depended upon careful technique at the time of the operation. Dr. LeMesurier believed that the Canadian choice of Syme's stumps was not influenced in any way by the type of artificial leg used. An important question to be settled is the length of time that a Syme's stump can be expected to stand up under the constant strain of weight-bearing. The Ministry of Pensions had reported that of fifty-four such cases followed between 1918 and 1933, re-amputation at a higher level had been necessary in thirty-eight. In Toronto, however, of a series of fifty-three cases, not a single Syme's stump had required re-amputation since 1922, and twenty of these patients were operated upon prior to that year. The stumps were excellent.

Dr. R. H. Kelham, Roehampton, explained the views of the limb-fitting surgeons for the Ministry of Pensions. He remarked on the large number of Syme's amputations performed in the last war, with re-amputation necessary later at a higher level. Many of these patients had been unable to tolerate end-bearing for more than eight years, and of those who had undergone re-amputation, not one failed to express his gratitude at being provided with a stump which gave complete confidence. A particular advantage was the better appearance of the limb, which is of importance to a woman.

Mr. W. A. Cochrane, Edinburgh, made a plea for further consideration by British surgeons of the advantages of the Syme amputation.

In a paper on "Intertrochanteric Fractures", Mr. Norman Capener, Exeter, described the use of gimlets inserted into the femur and incorporated in plaster. This is a simplified application of the Roger Anderson method.

A paper was read by Prof. H. J. Seddon, Oxford, on "The Rate of Regeneration of Peripheral Nerves in Man". It has long been believed that the rate of regeneration is about one millimeter a day, although exact determinations have never been made. There are three possible methods of investigating these rates:

1. Serial reinnervation of muscles. If the level of a lesion is known, as well as the points of entry into muscle of the various motor branches below the lesion, and the time of appearance of the first contraction in each muscle, then it is possible to construct a graph, showing the rate at which the process of regeneration spreads down a nerve trunk. A number of estimates made in this way showed that the rate after complete division was probably slower than after a lesion in continuity (axonotmesis). The difference was in the rate itself, and not merely in the delay at the site of the lesion or at the motor end-organs. Stopford's data from the last war, analyzed in this way, gave a rate for sutured nerve of six-tenths millimeters a day (radial nerve); but in axonotmesis (almost all cases of radial-nerve injury occurring in closed fractures of the humerus), the rate was one and four-tenths millimeters a day in the author's cases.

2. The return of sensibility in a long zone of skin innervated by one nerve can be worked out in a similar way. The rate for the return of pain sensibility was found to be about one and two-tenths millimeters a day.

3. Observations have also been made on the rate given by Tinel's sign, — reliable only in cases of suture, and then only when it moved down the nerve with reasonable regularity. The sign corresponds fairly closely with the position of the wave front of fibers and is due to direct stimulation of the fiber tips. It is only to be expected, therefore, that the rate of progress is faster than are rates dependent upon functional maturation. In the few complete observations that have been made, the rate was found to be 1.75 millimeters a day.

Mr. W. S. Diggle, Liverpool, presented a cinematographic demonstration of "The Treatment of Fractures of the Shaft of the Femur on the Thomas Splint".

Improved methods of obtaining "pneumo-arthrograms" in lesions of the semilunar cartilages were described by Dr. C. H. Cullen and Dr. G. Q. Chance, of Warrington.

Seventy to 140 cubic centimeters of filtered air was injected into the suprapatellar pouch, the injections being continued until the patient felt his knee to be definitely tight. A crepe bandage was bound tightly above the patella, to force air into the lower part of the joint. Two principles were stressed: (1) The part to be x-rayed should always be uppermost, to allow the maximum amount of air to fill the area under examination; and (2) the x-ray tube should always be horizontal so that the central beam will pass through the segment of cartilage being examined. Dr. Chance had a series of cross-sectional views taken of each cartilage. In practice, these views are tangential in projection. A higher percentage of accurate preoperative diagnoses was claimed for these methods of pneumoarthrography.

On Friday afternoon, May 29, the members and guests visited the R.A.F. Rehabilitation Centre, at Hoylake, by permission of the Air Ministry. Mr. Watson-Jones gave a clinical demonstration at which he stressed the importance of carefully graduated muscle exercises, carried out initially under the guidance of the Medical Officer and later in the gymnasium under the control of physical training instructors and masseuses, and the value of various outdoor games in which the competitive team spirit was encouraged. The meeting was then addressed by Flight-Lieutenant Cantor who described the working of the Centre and the importance of keeping the patient's treatment under the close supervision of a medical officer. Squadron-Leader Dawes, the Commanding Officer, emphasized the importance of recreating mental and moral fiber in addition to restoring patients to full physical fitness.

The next meeting of The Association, the Annual Meeting, is scheduled for the early fall.

Current Literature

THE HAND. ITS DISABILITIES AND DISEASES. Condict W. Cutler, Jr., M.D., F.A.C.S.
Philadelphia, W. B. Saunders Co., 1942. \$7.50.

This book of 572 pages and 274 illustrations covers many aspects of the care of the hand. The hand is one of man's most useful members, and also one commonly injured. Trauma is often followed by infection. Due to the multiplicity of its structures, treatment of sepsis of the hand may task the surgical skill of those proficient in that field. It is unfortunately true that a majority of hand injuries and infections are of necessity first seen and often treated by physicians possessing meager experience with those problems. Upon the judgment used at the first treatment may depend the chances of a successful outcome. Since the prognosis in hand surgery may be grave under the best circumstances, a clear exposé of the subject is valuable to any physician, specialist, or practitioner, who is liable to be confronted with this problem.

This book fulfills well the requisites of a practical guide for the diagnosis and treatment of hand conditions. There is a chapter covering the anatomy of the hand, clearly illustrated by pictures and drawings. This is followed by a chapter on infections, which emphasizes the influence that anatomy plays in sepsis of the part. The care of special infections is also taken up.

Since trauma and sepsis form but a small part of hand disabilities and diseases, chapters follow on the subjects of burns, abrasions, contusions, puncture wounds, and foreign bodies. The treatment of incised and lacerated wounds, including injury to blood vessels, nerves, and tendons, is covered. Several methods of tendon and nerve suture are illustrated by drawings.

Fractures, dislocations, and amputations, including the management of compound fractures, are discussed. Repair and reconstruction procedures for restoration of function are given. Congenital deformities and tumors which may occur in the hand are reviewed. The effect of constitutional diseases, as reflected in the hand, is described. In fact, about every phase of hand disease has been thoroughly covered. Discussions have been well amplified with clear, pertinent drawings and illustrations. The book is what the author wished it to be,—a useful guide for those whose task it is to deal with the diagnosis and treatment of hand conditions.

DISABILITY EVALUATION. PRINCIPLES OF TREATMENT OF COMPENSABLE INJURIES.
Earl D. McBride, M.D. Ed. 3, Revised. Philadelphia, J. B. Lippincott Co., 1942.
\$9.00.

The preface to this book of over 600 pages states, "The purpose of this volume is to interpret the physiological and mechanical alterations arising out of injury to the motor structures of the human body, and to reasonably appraise and evaluate the extent of functional loss as it relates to the economic incapacity of the injured".

The just compensation of industrial accident and other cases of medico-legal injuries requires, as McBride has pointed out, a very careful medical analysis of each case. He has set up an elaborate "composite schedule of approximate evaluations for partial permanent disability", which takes into account many variables. Among them are age, multiple disabilities, occupation, and member involved. He arrives at the percentage of functional impairment of an injured member by assigning arbitrary weighted values to seven factors, the sum of which, in the case of total loss of use, would equal 100 per cent. These factors are: (1) delayed action, (2) awkwardness, (3) weakness, (4) insecurity, (5) diminished endurance, (6) lowered safety factor, and (7) adverse influence of conspicuous impairment.

This attempt to reduce disability evaluation to something approaching mathemati-

cal exactitude is certainly to be commended. However, the author's method seems unduly complex, and for that reason may not find general acceptance. It at least challenges critics to produce a better one.

Following the section devoted to the more general aspects of disability evaluation, there is a chapter in which an attempt is made to enumerate all the multitudinous factors encountered in a complete history and physical examination of a disabled person.

A section of ten chapters is devoted to joint stiffness, and one of similar length to fractures, in which there is a mathematical treatment of skeletal mechanics. Chapters on The Industrial Back, The Trunk, Nerve Injuries, Amputations, Head Injuries, Injuries of the Eye, Injuries of the Ear, Burns, and Hernia complete the book.

The volume is attractive in format and typography, and is profusely illustrated with line drawings, photographs, and roentgenograms.

THE MANAGEMENT OF FRACTURES, DISLOCATIONS, AND SPRAINS. John Albert Key, B.S., M.D., and H. Earle Conwell, M.D., F.A.C.S. Ed. 3. St. Louis, The C. V. Mosby Co., 1942. \$12.50.

The number of books on fractures in the English language is not small. There are, however, very few which are modern and comprehensive, and which can be used as a practical working guide in the management of fractures, dislocations, and sprains.

The book received immediate recognition as an outstanding contribution when first published in 1934. Revised in 1938 and again in 1942, it has kept as nearly abreast of current practice as can reasonably be expected of any text. No other clearly surpasses it, and this reviewer feels that Key and Conwell lead the field. This volume has earned its place on the reference shelf of every one who treats fractures. The present edition contains revisions in the chapters on fractures of the spine, humerus, hip, and foot. The chapter on compound fractures has been rewritten, and contains a section on war wounds. The principles laid down are in accord with sound modern surgical practice, though every critical reader will find details and techniques recommended, which he would alter or discard for others better suited to his taste.

VOIENO-POLEVAIA KHIRURGIYA (War Field Surgery). Prof. M. N. Akhoutin (Peoples' Commissariat of Health of the U.S.S.R.). Moscow, "Medgis", 1942.

Books on field surgery may become obsolete before they reach the reading surgeon. The author is well aware of this fact. However, this book, written by a participant of the recent Russo-Japanese and Finnish conflicts, may be of great interest to the military surgeon. Most of the experiences are based on a rather stable front line, which permitted surgical interference in a large percentage of the cases within the safe period of time. But in spite of this, the general character of the book and the wealth of accumulated experience are of such nature and flexibility that it may be used with profit in any military situation. Although the author refers frequently to other sources, the book is a record of personal views and work.

It is divided into eighteen chapters encompassing most of the important questions of field surgery. The first chapter is devoted to the problems of organization of first aid, surgical treatment, and evacuation of the wounded.

A great deal can be learned from the ingenious improvisations and the ability to get the best use of material in the presence of scarcity. There are also interesting experiences with field surgery and evacuation of wounded in the subarctic cold. A detailed account is given of the various first aid and hospital units attached to various military groups, with description of the number and character of personnel, material needed, and the type of wounds treated in each unit. A number of illustrations and line drawings add much to the excellent description.

The other chapters consider the important problems of asepsis and anaesthesia in the battle zone, the management of traumatic shock, the use of blood transfusion, the

treatment of war wounds and infection in general, and the different regional wounds, as well as treatment of burns, electric injuries, frostbites, and others.

The book is written in Russian and consists of 300 pages. It is believed that its translation into English for the use of the English-speaking military surgeon would be of great use, provided a few minor changes are made. A comprehensive table of contents should be added, and a few parts of purely Russian interest should be omitted. Of course the translation and publication should not be delayed.

BLOOD GROUPING TECHNIC. A MANUAL FOR CLINICIANS, SEROLOGISTS, ANTHROPOLOGISTS, AND STUDENTS OF LEGAL AND MILITARY MEDICINE. Fritz Schiff, M.D., and William C. Boyd, Ph.D., with a foreword by Karl Landsteiner. New York, Interscience Publishers, Inc., 1942. \$5.00.

The purpose of this book and the varied groups for whom it is of value are well expressed in the title. The book covers a large amount of material, much of which has not been available in the usual textbooks for the physician and laboratory worker.

An excellent theoretical discussion is given of the agglutinins and agglutinogens which are found in man and animals. The usual agglutinable factors (A, B, M, and N) as well as the more rare types (Rh, P, G, H, X, Q, and E) are considered. It is shown that 160 kinds of human blood are distinguishable serologically.

The material on blood-grouping, transfusion, and maintenance of blood banks is of practical importance for many. The laboratory methods seem to be given in unnecessary detail.

The section on the application of blood-grouping to legal medicine is of distinct value. The genetic approach is an aid to the laboratory worker. The technique for handling material other than blood—such as blood stains, urine, saliva, gastric juice, and other body fluids—to obtain the agglutinins is given.

The work on the blood groups in various animals is not only of interest to the anthropologist, but of practical value to the laboratory worker.

The section on the history of blood groups and the survey of the blood groups in different races is unique and of special interest.

The extensive bibliography on this large but little known field adds to the value of this book as a reference.

LA BIOPSIA POR ASPIRACIÓN EN EL DIAGNÓSTICO DE LAS LESIONES ÓSEAS (Aspiration Biopsy in Diagnosis of Osseous Lesions). José Valls, Carlos E. Ottolenghi, y Fritz Schajowicz. Buenos Aires, Libreria y Editorial "El Ateneo", 1942.

This book by the three authors is probably the only one considering the subject of aspiration biopsy in its complete up-to-date form. The paper, the type, and the numerous excellent roentgenographic and histological reproductions are of the highest quality, and add to the most interesting and well-balanced treatment of the subject. It is divided into three parts: general, special, and an original addition on biopsy by aspiration in the diagnosis of lesions of the vertebral bodies.

The general introductory part describes in detail the various methods and apparatus used by the authors and others; considers the advantages and disadvantages of the method in comparison with surgical biopsy; and gives the technique of aspiration and of the microscopic examination of the material obtained; and an instructive histopathological study of benign and malignant tumors.

The special part treats under separate headings the metastatic, primary malignant, and benign tumors, bone cyst, giant-cell tumors, hydatidosis, von Recklinghausen's disease, and the chronic specific and non-specific infectious diseases. Most of the discussions are accompanied by illustrative case histories with roentgenograms, smears, and histological reproductions.

The last part, concerning the aspiration diagnosis of the vertebral bodies, is based on original studies of the anatomy of approach. The authors find that the fourth, fifth,

sixth, and seventh cervical vertebrae can be safely approached by the lateral route. The thoracic spine can be approached only below the tenth vertebra. All the lumbar vertebrae can be examined. By the use of a simple apparatus and a biopsy needle, the authors have been able to reach a high degree of accuracy in establishing the diagnosis of involved vertebrae. Many roentgenograms, histological pictures, and a reproduction of photographs of gross pathological specimens illustrate this part of the text. There is a very good multilingual list of references at the end of the book.

SYNOPSIS OF PATHOLOGY. W. A. D. Anderson, M.A., M.D. St. Louis, The C. V. Mosby Co., 1912. \$6.00

The author has condensed in a small volume a very comprehensive coverage of the entire field of general pathology. The text is very fully illustrated and the publisher is to be commended for the excellence of the reproductions which add greatly to the clarity of the descriptions.

The chapter on Bone, Joints and Tendons shares with the other subjects discussed the favorable commendation which the entire work deserves. In this chapter there are three instances where it seems to the reviewer that the text is open to criticism.

1. In the discussion of Strumpel-Marie disease, there is not enough stress laid on the fact that the essential lesions differ from those of rheumatoid arthritis, with which it is compared, in that they are largely confined to the intervertebral and costovertebral ligaments, and, except for an occasional involvement of the hip and sacro-iliac joints and most infrequently of the shoulder joint, the pathology is confined to the spine.

2. In the section on osteo-arthritis one gets an impression that pain is not a conspicuous symptom. Though not so severe, and for this reason not so crippling, as rheumatoid arthritis, nevertheless, there may be a good deal of discomfort in Heberden's nodes, and in hip and knee-joint involvements.

3. There is still some difference of opinion in regard to the primacy of bone and joint tuberculous involvements. Some believe that the extension is from bone to joint, whereas other observers think the reverse is the rule. It is certainly true that the primary focus is most commonly in the lung, or certain of the glandular structures draining the upper air passages, or about the bronchial tree, and no physical examination of a patient suspected of having tuberculous lesions of the bones or joints can be regarded as complete unless careful search has been made for evidence of pulmonary or glandular invasion at some time, even though there may be no present reason to suspect their existence.

The book is an excellent compendium of general pathology.

ANais DO 4.º CONGRESSO BRASILEIRO DE ORTOPEDIA E TRAUMATOLOGIA 1940 (Annals of the Fourth Brazilian Congress of Orthopaedics and Traumatology). São Paulo, Sociedade Brasileira de Ortopedia e Traumatologia, 1942.

The "Annals" is a substantial book of over 500 pages, paper bound, and well published. Due to various circumstances it appeared after a delay of two years. However, it represents an excellent and complete report of the Fourth Brazilian Congress of Orthopaedics and Traumatology, edited by the Brazilian Society of Orthopaedics and Traumatology.

The book contains many original articles, reports, and observations by the Brazilian orthopaedic surgeons. The treatment of fractures of the spine occupies 174 pages and is represented by several articles. In "Treatment of Fractures of the Vertebral Column" by Dr. Renato Da Costa Bomfim, the author gives a comprehensive review of the entire subject with thirty-three case reports, many line drawings, roentgenograms, and photographs. In recent lesions the author is opposed to reduction by progressive traction, and advocates immediate reduction, he is also opposed to early laminectomies. Other articles on this subject are: "Treatment of Fractures of the Vertebral Column" by Dr. Bruno Maia, "A New Type of Table for Reduction of Fractures of the Spine" by Prof. Domingos

Define; "Fracture of the Vertebral Column" by Prof. Lelio Zeno; and "Telcradiography of the Spine" by Prof. Barros Lima.

The following is a list of other articles read before the Congress:

Autoplastic Articular Reconstruction of a Flail Elbow, by Dr. Achilles de Araujo,

The Social Function of Orthopaedic Surgery, by Prof. Barboza Vianna,

Oudard's Operation for Recurrent Dislocation of the Scapulohumeral Joint, by Dr.

Alcino Coimbra,

A Case of Recurrent Dislocation of the Shoulders, by Dr. Rubem da Rocha Martins,

Radiotherapy of Scapulohumeral Periarthritis, by Dr. Achilles de Araujo and Dr.

Carlos Osborne,

A New Stabilization Procedure for the Tibiotarsal Joint in Paralytic Feet, by Prof.

Domingos Define,

Statistical Study of Club Feet, by Dr. Ivo Define Frasca,

Pterygium Colli Congenitum, by Dr. J. Rebelo Neto,

Serious Injuries of the Hand, by Prof. Lelio Zeno,

Fracture of the Medial Condyle of the Elbow Involving the Joint, by Dr. Mario de

Abreu,

Operative Treatment of Fractures of the Ankle, by Dr. Orlando Pinto de Souza,

Original Apparatus for Suspension of the Hand, by Dr. M. Weinberger,

Parathyroidectomy in Engel-Recklinghausen Disease, by Dr. S. Hermeto Junior,

Lumbagos, by Dr. Silvio Marques,

Reflex Sciatic Pain in Disturbances of the Lumbar Region, by Dr. A. Steindler,

Delahaye's Arthrodesis in the Cure of Tuberculosis of the Knee, by Prof. Barros

Lima,

Presentation of a Frame for Reduction of Fractures of the Upper Extremity, by Dr.

Achilles de Araujo,

Agnesia Sacrococcygeal, by Dr. Bruno Valentin,

Plastic Surgery in the Correction of Deformed Hands, by Prof. Lelio Zeno,

Illustrative Case of the Value of Metallic Osteosynthesis in the Treatment of Medial

Fractures of the Neck of the Femur, by Dr. Orlando Pinto de Souza,

Fractures of the Ankle, by Dr. Octavia Caputti and Dr. Oscar Rudge.

THE MEDICAL ANNUAL. A YEAR BOOK OF TREATMENT AND PRACTITIONER'S INDEX.

H. Letheby Tidy, M.A., M.D.(Oxon.), F.R.C.P., and A. Rendle Short, M.D., B.S., B.Sc., F.R.C.S., Editors. Bristol, John Wright & Sons, Ltd., 1942.

This book is a summary of treatment obtained from a review of medical literature during the past year. The articles have been taken chiefly from American and British medical journals since many others, as the editors mention, are not available because of the war. A part of the printing was destroyed by bombs before the volume was completed. Despite these difficulties the editors have brought out a most creditable volume. The material is well arranged, with numerous illustrations and editorial comments. There is a comprehensive index. The section on orthopaedic surgery, under the able editorship of Prof. T. P. McMurray, is presented especially well. The discussions and editorial notes, while concise, are sufficiently full to give a clear picture of the treatment under discussion. As a year book of treatment it is a superior work.

SUBCUTANEOUS RUPTURE OF THE ILIOPSOAS MUSCLE. A REPORT ON THREE CASES.

Gunnar Strandell. *Acta Chirurgica Scandinavica*, LXXXVI, 149, January 1942.

Ten cases from the literature and the writer's three new ones are the basis for a study of rupture of the iliopsoas muscle. In two cases there was a complicating lesion of the femoral nerve, and suppuration was not infrequent. Five of the thirteen patients died, but of the etiological condition and not of the iliopsoas rupture. Tetanus was responsi-

ble for the rupture in two cases. Other causes were lifting heavy weights, gymnastics, jumping, falling backward, and a fall with the legs abducted. The differential diagnosis between this entity and hernia of the obturator, coxitis, psoas abscess, and abdominal lesions must be considered. Operation is indicated to stop the bleeding, remove the clots, and prevent infection. If the hematoma is already infected, drainage should be instituted. Muscle suture is not satisfactory.—*Walter P. Blount, M.D., Milwaukee, Wisconsin.*

ÜBER INTERTROCHANTERISCHE OSTEOTOMIE STATT SUBTROCHANTERISCHE (Intertrochanteric Osteotomy Instead of Subtrochanteric). Nils Silfverskiöld. *Acta Chirurgica Scandinavica*, LXXXVI, 379, March 1942.

For sixteen years the writer has used the intertrochanteric or pertrochanteric osteotomy in preference to all others at the proximal end of the femur. The operation takes somewhat longer, but in many ways is preferable. There is less danger of splitting the bone of the trochanter than that of the shaft lower down. The cut surfaces are large and do not tend to displace. Fixation for four weeks is adequate for consolidation.

The operation is carried out on an orthopaedic table with bilateral extension. The greater trochanter is cut off with a chisel, and is reflected upward with the attached abductor muscles. Elevators are inserted just proximal to the lesser trochanter. A wedge of spongy bone is removed with the apex just proximal to the lesser trochanter. The leg is then abducted until the wedge is closed. When the hip is movable, it is necessary to hold the proximal fragment with a strong hook. The greater trochanter is then brought down and sutured in place. A bit of the aponeurosis of the vastus lateralis is left attached for this purpose. If it is desirable to increase the power in abduction, a piece of bone is laid under the greater trochanter in order to displace it laterally. A plaster cast is applied for four weeks.—*Walter P. Blount, M.D., Milwaukee, Wisconsin.*

CHORDOMA IN A THORACIC VERTEBRA. C. J. Hansson, *Acta Radiologica*, XXII, 598, 1941.

The author reports the case of a male, forty-five years old, admitted with complaints of hyperaesthesia at the level of the sixth and seventh thoracic segments. The patellar reflex on the left side was abnormal. The roentgenogram revealed destruction of the arch of the seventh thoracic vertebra. After excluding tuberculosis, a diagnosis of primary bone tumor was made and roentgenotherapy was instituted. Destruction of the vertebra was progressive, despite this treatment.

An exploratory operation was carried out through an incision which is not mentioned. "The arch and the posterior portion of the body of the seventh thoracic vertebra were found to be disintegrated. The cartilage between the seventh and eighth thoracic vertebra was transformed into a bluish tumor mass, which had penetrated into the vertebral body. The tumor tissue was curetted out and two tibial splints were fastened, one on each side of the spinous processes which had been laid free."

Microscopic examination revealed a chordoma. Two years after operation "slight paraesthesia and a spastic condition of the legs were still in evidence, but the pain had disappeared. There was no sign of a recurrence".—*Henry Milch, M.D., New York, N. Y.*

EXPERIENCES WITH EPIDURAL CONTRAST INVESTIGATION OF THE LUMBO-SACRAL CANAL IN DISC PROLAPSE (PERABRODIL). Folke Knutsson. *Acta Radiologica*, XXII, 694, 1941.

Since 1940, when Lindblom first began investigation of the epidural space, some twenty cases have been studied. Perabrodil in 35-per-cent. solution is used as the contrast medium. After local anaesthesia with ten cubic centimeters of 1-per-cent. novocaine, twenty cubic centimeters of the contrast solution is quickly injected into the epidural space. Lateral, anteroposterior, and oblique roentgenograms are made in quick succession.

As a consequence of these studies, the author expresses the opinion that the method is valuable in the discovery of large disc prolapses. Small disc lesions, however, cannot be demonstrated by this procedure.—*Henry Milch, M.D., New York, N. Y.*

EINE ANATOMISCHE STUDIE ÜBER LUMBALE ZWISCHENWIRBELSCHEIBENPROTRUSIONEN UND ZWISCHENWIRBELSCHEIBENBRÜCHE IN DIE FORAMINA INTERVERTEBRALIA HINEIN (Anatomical Study of Protrusions of the Lumbar Intervertebral Disc and Ruptures of the Disc into the Intervertebral Foramina). K. Lindblom. *Acta Radiologica*, XXII, 711, 1941.

All who have had occasion to study the problem of disc protrusions have been impressed by the fact that in two apparently similar cases, one might show a typical disc protrusion, while in the other neither roentgenographic nor surgical substantiation could be found. In the latter type of case, Lindblom believes the protrusion is into the intervertebral foramina, rather than into the spinal canal. To resolve this problem, the vertebral columns of fifty-one cadavera, between the ages of nineteen and eighty-seven years (average age, fifty-five years), were examined. Of these only three, aged nineteen, thirty-eight, and forty-one years, respectively, were found normal. In the other forty-eight cases, some pathological appearance was found. In six cases, there was a constriction in the dura, corresponding to a disc protrusion. In none of the cases, however, was any hypertrophy of the ligamentum flavum found. In seven cases, the spinal nerves were found flattened in the intervertebral foramina. In all cases, one or more of the intervertebral discs showed evidence of degenerative phenomena and rupture. In the worst cases, all of the discs in a given spine were the sites of disease. In twelve cases there was definite protrusion of the disc into the intervertebral foramina.—*Henry Milch, M.D., New York, N. Y.*

THE OPERATIVE PROCEDURE IN INTERVERTEBRAL DISK PROTRUSIONS. H. Olivercrona. *Acta Radiologica*, XXII, 743, 1941.

During the past few years the author has abandoned bilateral laminectomy and transdural resection of protruded intervertebral discs. As a general rule hemilaminectomy and subdural removal of the disc has been possible. Even where this lesion is so large that bilateral laminectomy is necessary, the operation should be completed without opening the dura, if possible.

The author calls attention to the fact that protrusion of the nucleus pulposus should be carefully differentiated from protrusions of the annulus fibrosus. In the former case, an irregular, gritty surface is presented. In the latter, a firm, smooth bulge on the medial side of the corresponding nerve root is seen. No effort should be made to remove the protruded annulus fibrosus. On the contrary, the dura should be opened and the mass more carefully investigated. "If a protrusion of the annulus fibrosus is present, the bulge seen outside the dura will be recognized as a swelling situated immediately mesial to the dural opening, through which the root, usually the fourth or fifth lumbar, is emerging. The root is compressed either against the dural opening or more probably against the margin of the ligamentum flavum, forcing the posterior wall of the intervertebral foramen. As already pointed out, it is useless to try to remove the protruding part of the annulus fibrosus. Instead, the sensory root running over the protrusion is picked up in a small hook and divided or crushed with a silver clip."

The author states that this procedure has been performed, but the results are too recent to warrant the drawing of any conclusions.—*Henry Milch, M.D., New York, N. Y.*

ON MOVEMENTS OF FLUID INSIDE THE CEREBRO-SPINAL SPACE. Haakon Reitan. *Acta Radiologica*, XXII, 762, 1941.

During the course of myelographic studies, the author noted movements of the spinal fluid which appeared to be paradoxical with regard to respiration. On inspiration,

the column of contrast medium rose and became more slender, while on expiration the column sank and became thicker. In large part, the decrease in the diameter of the column seemed to be the cause of its elevation in the spinal canal. This phenomenon was noted in the erect position and to an even greater degree in the horizontal position. The amplitude of excursion of the contrast column was definitely increased when the intra-abdominal pressure was increased as in Valsalva's test.

The author attributes these effects to engorgement of the internal vertebral venous plexus. This causes a narrowing of the subdural space, a reduction in the diameter of the contrast column, and a consequent rise in the height of the column. He calls attention to the fact that, as a result of the central concentric displacement of the contrast medium, the column may lose contact with a protruding disc, and the characteristic deformity of the roentgenogram may disappear during inspiration.—*Henry Milch, M.D., New York, N. Y.*

COMPLICATING FACTORS IN THE TREATMENT OF INJURIES TO MENISCI OF THE KNEE JOINT. Clay Ray Murray. *The American Journal of Surgery*, LV, 262, February 1942

This is a very excellent paper dealing mainly with some observations which in the past have been either overlooked or minimized. The first of these factors is the rapid and profound hypotonia and atrophy of the rectus femoris, the vastus intermedius, and the vastus lateralis which follow any kind of intra-articular damage to the bone. It comes on in a few days' time, and consequently is not due to disuse, but no explanation is offered. When an operation is performed, this feature is further intensified.

Since it has been shown that normal knee-joint stability is dependent mainly on musculature, and that the ligamentous apparatus is mainly a secondary check, it is desirable to rehabilitate the knee, whether conservatively or operatively, for maximum return of function of the muscles.

The author does not believe in repeated attempts at conservative treatment in recurrent meniscus lesions. He does, however, urge primary operation only when reduction of locking cannot be accomplished under anaesthesia. In other cases he aspirates the hemarthrosis if it is large enough to warrant it. Then a cast is applied snugly from foot to groin, and the patient is urged to walk as much as possible and to exercise the quadriceps muscle frequently. The cast is removed in one month, and the patient is urged to do more exercises on his own. If after such management recurrence occurs, operation is advised.

The second important factor is the incision. The author urges the parapatellar incision, because in only 30 per cent. of the cases is a clear-cut preoperative diagnosis of cartilage injury made, the small incisions are not adequate for dealing with other pathology.

The third important factor is the use of a tourniquet. He feels that, although a dry field is desirable, the anaemia of the extremity is no small matter in further interfering with muscle tone. He does not use a tourniquet, but places the patient in the Trendelenburg position, and by mosquito forceps, cautery, and careful control of bleeding before opening the synovial membrane, the joint work is done in a fairly dry field.

The author feels that muscle atrophy and loss of muscle tone following knee injuries is more extensive than is usually believed.—*T. J. Gieteman, M.D., Iowa City, Iowa.*

SEUDOARTROSIS DEL ESCAFOIDES. TRATAMIENTO CON INJERTO ÓSEO (Non-Union of the Scaphoid Treatment by Means of a Bone Graft) Oscar R. Maióttoli. *Anales de Cirugía*, VII, 321, 1941.

The author prefers the use of a bone graft in the treatment of ununited fractures of the scaphoid. He states that he has had consistently good success with this procedure,

and that excision is not indicated ordinarily. A case is presented in detail. The injury had occurred seven months before the patient was first seen by the author. Examination revealed tenderness in the middle of the anatomical snuff box, with a good deal of pain on motion, and disability. The roentgenogram showed an ununited fracture near the middle of the scaphoid. Operation produced an excellent result. The author lays considerable stress on certain points in the operative technique. An incision is made over the radial end of the scaphoid in order not to interfere with the circulation of the bone. After visualizing the end of the scaphoid, a hole of suitable size is drilled across the fracture site. A bone graft is then taken from the tibia and carefully prepared to fit the drill hole in the scaphoid. The bone graft is driven into place. Before cutting off the excess of the bone graft, the author takes a roentgenogram, using sterile precautions. The purpose of this is to make sure that the drill hole is in the right place, and that the graft has not extended beyond the bone and into the adjacent bone of the wrist, which might produce a fusion of this joint. The correct length of the bone graft is determined by means of the roentgenogram, and the excess is cut off. The author feels that the use of a bone graft in ununited fractures of the scaphoid is the best procedure, because it gets rid of the disability from the ununited fracture and at the same time does not produce additional disability by removing a bone which normally should be in the wrist.—

Louis W. Breck, M.D., El Paso, Texas.

THE EXPERIENCE OF THE CANADIAN ARMY AND PENSIONS BOARD WITH AMPUTATIONS OF THE LOWER EXTREMITY. W. E. Gallie. *Annals of Surgery*, CXIII, 925, 1941.

This article is a presentation of the experience of Gallie, LeMesurier, Robertson, and Dale in the handling of 2,448 amputations of the lower extremity. These physicians have been in charge of the Pensions Military Hospital and the artificial limb factory connected with the Hospital since 1916.

It is stated that a good Syme amputation is the best amputation possible. In its favor are: (1) In the bedroom and bathroom the patient can walk on the stump without taking the trouble to put on his artificial limb; and (2) when fitted with a good artificial limb he can walk or run on his feet all day.

Against it is the unsightly ankle which makes it contra-indicated in the female.

In reviewing the unsatisfactory results from the Syme's operation, it was learned that the chief defects have been improper relationship of the weight-bearing heel pad to the bones of the leg; looseness of this pad, so that it wobbles about on the end of the stump when weight is applied; and pain resulting from irregular bone points, adherent scars, and neuromata.

The Syme operation has no application on the battle field or anywhere where there is risk of infection. The operation is not popular with limb makers because they have difficulty in fitting a limb properly.

In the discussion of amputations between the ankle and knee, the author has nothing favorable to say. In his experience most of the patients with these amputations have been reoperated upon many times, and have ended with above-the-knee amputations. These stumps will not stand up under the strain of a day's work because they are side-bearing stumps, and these areas are unaccustomed to weight-bearing and are not capable of it.

In above-the-knee amputations, the end-bearing stump produced by the Gritti-Stokes procedure is the one of choice. Any workingman with the need of an amputation above the level of a Syme amputation is subjected to a Gritti-Stokes procedure. In comparing this amputation with mid-thigh amputations, it is stated that an end-bearing stump gives a man a solid grip on the ground, and permits him to walk better. He is able to stand for long periods of time while bearing weight on the tough skin in front of the knee. Also, being equipped with a stump socket of the corset variety which does not reach the top of the thigh, he has much more freedom of hip movement.—

Melville Rosenbusch, M.D., Iowa City, Iowa.

MINOR CAUSALGIA FOLLOWING INJURIES AND WOUNDS. John Homans. *Annals of Surgery*, CXIII, 932, 1911.

Major causalgia, well recognized as the symptom complex which follows injuries to certain great nerves, is mentioned. This paper, however, deals with minor causalgia which is excited not by trauma to large nerves and vessels, but by a great variety of lesser injuries, blows, crushes, fractures, thorns, and bites of animals. It also may accompany the inflammatory, obstructive form of thrombophlebitis, doubtless because the nerves surrounding the great vessels are caught in the inflammation. The changes in minor causalgia include atrophy of bone, disorders of joints, oedema, paraesthesia, and vasomotor dysfunction, which usually leave a cool, smooth, bluish skin, but occasionally cause vasodilatation. All these may appear together or in various combinations,—a sensory-sympathetic disorder which may even spill over to the motor side. The basic feature, pain, depends upon a very unstable reflex which must be broken up to obtain relief.

Livingston recommends procainization or excision of the source of pain,—the "trigger-point". Lehman uses periarterial sympathectomy. Smithwick is most radical, and employs the operation of sympathectomy. The author favors sympathetic block and repeats this as often as six times in some cases. If this fails, he resorts to sympathectomy. All these methods are effective. There is no especial indication for any one of them. It is stated, however, that periarterial sympathectomy is best adapted to well-localized causalgias,—for example, a radial operation for the thumb, an ulnar operation for the ulnar field.

Following relief, the patient should rest the limb for several months since additional trauma may cause a return of the symptoms.—*Melville Rosenbusch, M.D., Iowa City, Iowa.*

NEUROPATHIC ARTHROPATHY OF THE ANKLE JOINT RESULTING FROM COMPLETE SEVERANCE OF THE SCIATIC NERVE. Graham Kernwein and W. F. Lyon. *Annals of Surgery*, CXV, 267, February 1942.

This is a very complete and detailed account of a case of complete severance of the sciatic nerve with a six-centimeter defect, so that no attempt to repair the nerve was made. The patient had loss of motor and sensory function of all structures below the knee, but returned to work. Six months after his return to work sudden marked brawny induration of the extremity developed from a point below a constricting scar in the lower thigh. The ankle was in marked varus deformity. An amputation at the knee was performed because of the lymphoedema and paralysis. Roentgenographically, clinically, and microscopically the ankle joint was a typical neuropathic joint. The article contains excellent roentgenograms and photographs of the gross and microscopic specimens.

In the discussion the authors state that neuropathic joints develop in approximately 10 per cent. of all tabetic patients. They occur in 30 to 40 per cent. of patients with syringomyelia. Milgram doubts the existence of a neuropathic joint as a result of a peripheral nerve injury.

The theories of pathogenicity are three in number. The first contends that neuropathic joints develop as a result of injury to a nerve, and a low-grade spirochetal infection of the joint itself. There is no evidence for this. The second considers a disturbance in the nervous trophic regulatory mechanism as etiologic. There is no evidence of special nerves whose function is merely trophic. In poliomyelitis marked trophic changes occur, but no neuropathic joints develop. The third theory is a mechanical one. It states that neuropathic joints are the result of trauma to a joint deprived of sensation.

The case presented supports this latter theory. The authors also believe that the mechanical theory holds true in neuropathic arthropathy from any cause.—*Melville Rosenbusch, M.D., Iowa City, Iowa.*

MALIGNANT TUMORS OF SYNOVIAL ORIGIN. Crenshaw D. Briggs. *Annals of Surgery*, CXV, 413, March 1942.

A brief summary of this subject reveals that malignancies arising from the joint capsule, bursal wall, or tendon sheaths, all stem from synovial tissue which is mesenchymal in origin. The synovial membrane may be divided into two parts histologically, an outer wall composed of dense connective tissue known as the fibrous layer, and an inner or synovial layer which is more cellular and is thought by many to secrete the viscid colorless fluid of the joint cavity. Each layer may give rise to a malignancy which differs histologically. Those arising from the outer layer are usually confused with the more common fibrosarcoma, and can only be distinguished from them by gross examination at time of operation. Those arising from the synovial layer are more cellular, and present papillary formations. The cells are epithelioid and cuboidal. The papillary formations have not been mentioned in previous papers on this subject. These formations reveal a central portion composed of a stroma of fairly typical fibroblasts, which is covered by a layer of cells of a more cuboidal type, with a large vesicular nucleus and acidophilic cytoplasm. The whole section is usually quite vascular. Mitotic figures are present, but not numerous.

These tumors appear between the third and fifth decades, present swelling as the initial symptom, and pain only occasionally. The duration of the symptoms is approximately two years. Clinically there is nothing very noteworthy about them, and more frequently than not they are diagnosed benign bursae or cysts. It is thus especially important to examine them microscopically.

A diagnosis of malignancy is made whenever a cystic tumor arising from a synovial structure microscopically shows papillary formation. This of course is contrasted both clinically and microscopically from villous arthritis.

Treatment consists of radical local resection whenever feasible,—when the tumor appears encapsulated. Wherever this cannot be performed without injury to important structures, amputation is indicated. Where excision has been employed, radiation should be used as an adjunct.

Prognosis is not so poor as the general literature would have us believe. Metastasis is late and to regional lymph nodes, and terminally to the lungs.

Nine cases are presented together with photomicrographs.—*Melville Rosenbusch, M.D., Iowa City, Iowa.*

SUBTALAR DISLOCATIONS. CASE REPORT OF THE INWARD TYPE. Robert A. Wise. *Annals of Surgery*, CXV, 445, March 1942.

Subtalar dislocations are interesting and unusual injuries. Baumgartner and Hugener collected all recorded cases up to 1907; Shands made an additional collection up to 1927; and the author has collected all cases (ten) since.

Four types are classified according to the position of the foot. The pathology and treatment of each is described.

The talotibial relationship is usually not disturbed. The navicular and calcaneum, together with the other tarsal bones, are displaced.

In the *inward* type the head of the talus is completely separated from the navicular and lies at the lateral side of the foot on the superior surface of the cuboid. The extensor tendons are medial to the head of the talus, and the cruciate crural ligament lies beneath it. The calcaneum is displaced inward. Ligamentous damage is extensive with rupture of the dorsal talonavicular, the interosseous talocalcaneal, the anterior and lateral talocalcaneal, and the anterior talofibular ligaments. Rupture of the powerful interosseous talocalcaneal ligament is essential to the production of the dislocation.

In the *outward* type, the head of the talus lies on the medial side of the foot in relation to the inner surface of the navicular, while the calcaneum is displaced outward.

In the *backward* type, the calcaneum is displaced backward and the head of the talus rests upon the superior surface of the navicular.

In the *forward* type, the calcaneum is displaced forward and the head of the talus rests upon its superior surface.

Treatment in early simple cases consists in closed reduction under anaesthesia, with the knee flexed to relax the tendo achillis. Traction is made in the long axis, and the foot is returned to its normal position while an assistant puts pressure over the head of the astragalus. Dorsiflexion of the foot helps relax the tibialis posterior tendon, and is useful in the reduction of the outward and inward types. In the backward type, extreme plantar flexion is helpful in obtaining reduction. Most cases of forward dislocation require open reduction.

Arthrotomy is required when closed reduction fails. Late, unreduced cases require open reduction and arthrodesis of the involved joints.

A case of inward dislocation is presented, together with an account of the treatment by closed reduction. Photographs and roentgenograms accompany the presentation.—*Merrill Rosenbusch, M.D., Iowa City, Iowa.*

RECENT ADVANCES IN THE DIAGNOSIS AND TREATMENT OF RUPTURED INTERVERTEBRAL DISKS. Walter E. Dandy. *Annals of Surgery*, CXV, 514, April 1942.

This paper states that the diagnosis of ruptured intervertebral disc can be made almost 100 per cent. of the time. There are several reasons for this. In the first place the history is characteristic. There is low-back pain which spreads down the posterior aspect of one or, at times, both legs, and is intensified by coughing or sneezing. The pain recurs with more or less free intervals between attacks. In examination one item only is of importance, — namely, the reduction or loss of the Achilles reflex on the affected side. The author deprecates the use of contrast media in the spinal canal. Love and Spurling have statistical studies which show that 96 per cent. of all ruptured intervertebral discs are situated at the fourth and fifth lumbar vertebrae.

The syndrome caused by a "concealed disc", identical with that described above, represents 25 per cent. of all disc lesions. A concealed disc is one that protrudes so slightly that it could hardly be found at operation unless one explored the subdural region with great care. Always there is a very tiny bulge of the intervertebral space, with thickening of the spinal ligament; it indents with pressure of the forceps, and gives a sense of fluctuation upon pressure by them. When incised, the forceps dip deeply into the cavity of the disc. At times it is laterally placed, at other times at or near the midline. In every case the emerging nerve has been adherent to it. The interior of the disc must be opened. It is not necessary or possible to remove the contents completely to produce a cure, but it is necessary to open the disc as widely as possible, so that the non-viable content—that is, the sequester—may be extruded. From April 1, 1941, to December 10, 1941, the author diagnosed correctly sixty-three cases without the use of contrast media.—*Melville Rosenbusch, M.D., Iowa City, Iowa.*

ROENTGENOLOGIC CHANGES IN THE BONES IN CASES OF PSEUDOHYPERTROPHIC MUSCULAR DYSTROPHY. Bernard S. Epstein and Joseph L. Abiamson. *Archives of Neurology and Psychiatry*, XLVI, 868, 1941.

The authors question the current concept that this disease is one which affects the muscular system primarily, and present seven cases of progressive muscular dystrophy in which roentgenographic changes were demonstrable. The most common changes were symmetrical diminution in the size of the scapulae, rather large humeral heads in relation to the small, shallow glenoid fossae, slender humeral shafts with widened medullary canals, and thin but not atrophic cortices. In all the patients the pelvis was small, with flaring iliac bones, prominent ischial spines, and marked coxa valga. These pelvic changes, aside from the coxa valga, may be accounted for by the fact that the patients had spent many years in wheel chairs.

The authors doubt that the osseous changes result from disuse. The usual changes

associated with disuse are rarefaction and decalcification, particularly in the articular ends, but in the authors' series these changes did not occur; atrophy of disuse is progressive, but their studies showed no progressive loss of density of the bone over a period of years.

They conclude that the older view—that muscular dystrophy is a disease which involves muscle only—may have to be revised to include the concept of a more generalized pathological process. In addition to the alterations in creatinine metabolism and the possible disturbance in the endocrine glands, there is involvement of bone. It is their opinion that the changes in bone cannot be explained on the basis of disuse alone, but may be an expression of a mesodermal defect resulting in muscular and skeletal defects.—*V. Walkin, M.D., Iowa City, Iowa.*

HAEMANGIOMA OF THE HAND, INVOLVING PHALANGEAL BONES, WITH DISTINCTIVE RADIOLOGICAL APPEARANCE. Konrad Hirschfeld. *The Australian and New Zealand Journal of Surgery*, XI, 136, 1941.

A man, twenty-four years old, complained of pain and swelling of his left hand, and index and middle fingers, of fifteen years' duration. There was a soft, elastic swelling, a globular mass, between the second and third metacarpal heads. The swelling and pain increased when the hand was held in the dependent position. Roentgenograms revealed abnormal separation of the second and third metacarpal heads, and slight thickening of the periosteum of the metacarpals with some areas of rarefaction in the cortex. The proximal phalanx of the index finger showed a central area of honeycombed rarefaction. The treatment consisted of the injection of fifteen cubic centimeters of 5-per-cent. solution of sodium morrhuate into various parts of the swelling. A severe reaction followed immediately, but the end result was excellent.—*Daniel H. Levinthal, M.D., Chicago, Illinois.*

SURGICAL EXPERIENCES IN THE MIDDLE EAST. Julian Smith. *The Australian and New Zealand Journal of Surgery*, XI, 153, 1942.

This is an account of the author's experience with a surgical team of the Australian army in the western desert of Africa during the early months of 1941, and of subsequent work in a casualty clearing station in Syria. This work was done under difficult desert conditions where it was practically impossible to exclude dust from the operating theater; where water had to be brought from a distance of ten miles; and where electric light from portable generators was available only at times, while at other times surgery had to be performed with the aid of lamps and torches.

A small field autoclave was used for instruments, linens, gauze, and dressings. Gown and gloves were worn only for abdominal and head operations. Ether was the most frequently used anaesthesia and was preferred, although pentothal sodium used intravenously was found to be excellent for short operations. A blood bank was established on the day before a battle by taking blood from Group 2 and Group 4 donors selected from minor casualties. The blood was kept in the ice-box for a period not exceeding three days. In the author's opinion, transfusion is the only ideal means of resuscitation of a severely injured patient, and plasma is useful only in tiding a patient over a critical period until the proper restorative measures can be instituted.

In discussing the general treatment of wounds, the author recommends that the débridement include a thorough exploration with a wide incision in the deep structures. If, however, a wound is not seen until it is infected, the surgeon should content himself with providing drainage. The local and oral administration of sulfanilamide is routine, and the author is convinced of its value, having observed only seven cases of gas gangrene out of 1500 casualties, and in these infection was present when the patients arrived at the casualty clearing station. The use of a tight vaseline pack is condemned, since it will prevent free drainage. A plaster cast is employed in all compound fractures and in large muscle wounds.

Abdominal wounds require early operation. After the abdominal cavity is cleaned of blood and debris, small perforations are searched for and closed with a simple Z, purse-string suture of linen. Larger perforations frequently require anastomosis. The convalescence is stormy, and the prognosis is poor. Nine of the author's patients recovered out of nineteen who were operated upon.

Chest wounds have a surprisingly low mortality, and are not as urgent as abdominal injuries. Sucking wounds of the chest, however, demand immediate treatment; a few sutures of silk worm are placed deeply and tied firmly to close the opening. The treatment of other chest conditions in forward operating rooms is conservative.

For compound fractures of the femur, the thigh wound is opened widely, and a five-inch incision is made in the fascia lata to expose the fracture. Foreign bodies, loose bone, and devitalized tissue are removed. After hemostasis is secured, the wound is irrigated with hot saline, swabbed with acriflavine, and dried. Sulfanilamide powder is introduced, and a large blob of vaseline is placed on the wound, which is then covered with a flat gauze dressing. A Kirschner wire is introduced through the upper tibia, and the extremity is placed in traction in a Thomas splint with the knee flexed at 30 degrees.

Treatment of compound fractures of the humerus must be modified, because a patient cannot go into an ambulance with his arm widely abducted. Most of the author's patients are placed in a plaster slab applied to the postero-external surface of the extremity, extending from the vertebral border of the scapula to the metacarpal heads. The arm is held in slight abduction with traction applied by an assistant, and the elbow is flexed to 90 degrees. The plaster slab is held in place by a few turns of plaster bandage, and the extremity is fixed to the trunk by a few additional bandages, slight abduction of the arm being maintained.—*Daniel H. Levinthal, M.D., Chicago, Illinois.*

BASE HOSPITAL MANAGEMENT OF SOFT TISSUE INJURIES. B. K. Rank. *The Australian and New Zealand Journal of Surgery*, XI, 171, 1942.

This is an account of treatment of soft-tissue injuries by a faciomaxillary and plastic-surgery unit of an Australian general hospital. The author concedes the value of débridement and closed plaster in the early emergency treatment of larger wounds, but has found that continuation of this type of "passive" treatment for wounds with large skin losses and varying degrees of infection results in slow healing, with scars poor in texture and often unstable. Smaller wounds are usually excised in the forward operating theaters and allowed to heal spontaneously, with the common sequela of secondary infection and indolent "chronic wounds". These chronic wounds represent failure, as indicated by a retarding or arrest of normal secondary-intention healing, and by showing indurated, raised, and keloidial edges stopping abruptly at the granulating area, with no sign of the thin actively growing blue edge of a healthy wound. There is an undue amount of deep fibrosis which fixes the scar to the surrounding tissues, and gives rise to undue functional disability. The most important cause of these chronic wounds is infection with streptococcus pyogenes, which inhibits epithelial proliferation by a special histolytic property.

All wounds are cultured for streptococcus, and roentgenograms are made for foreign bodies. The patient's general condition is built up by proper diet, vitamins, and transfusion as indicated. Transfusion has been found necessary in practically all cases where the raw area is larger than six inches by six inches. After a careful preparatory routine, the raw areas are covered with skin grafts. The preparatory routine is designed to cleanse the wound of slough and debris, eliminate streptococci and other surface bacteria, reduce the granulating area to a firm regular base, and by massage and exercises to improve the function of the part. A daily bath in 2-per-cent. saline at 90 degrees is given for periods of one-half hour, increasing to three or four hours according to the patient's tolerance. Daily dressings are done after the bath, with rigid sterile technique. If streptococcus is present, all sloughs are removed and the wound is sprayed with sulfanilamide powder; a vaseline-gauze dressing containing one per cent. of balsam

of Peru is applied, over which moist saline packs are placed. If no streptococci are present, sulfanilamide is not employed; instead, wet packs of cusol are used. This preparatory routine is carried out until the wound appears clean and healthy with firm granulations.

Before the skin-graft operation, sulfanilamide is given by mouth for three days, and is continued after the operation; no sulfanilamide is given on the day of the operation. Grafting is performed by the pinch or razor method. Sulfanilamide powder is applied to the raw area before razor grafting and on top of pinch grafts. A dressing of the vaseline gauze with balsam of Peru is sutured to the skin edges and this is covered with a molded pack of paraffin and flanne wool for compression. An elastic bandage is then applied. The first postoperative dressing is done five days later, and the second, after two or three more days. Dressings are then done daily and the bath routine is resumed for patients with pinch grafts. If streptococcus infection has been present previously, the local use of sulfanilamide is continued.

The author's series consists of fifty skin grafts, of which twenty-five were done by the razor method. In 80 per cent. of the cases there was a satisfactory take. These good results are attributed particularly to the meticulous preparatory routine.—*Daniel H. Levinthal, M.D., Chicago, Illinois.*

PRELIMINARY REPORT ON INTERNAL DERANGEMENTS OF THE KNEE JOINT TREATED AT AN AUSTRALIAN GENERAL HOSPITAL, AUSTRALIAN IMPERIAL FORCE ABROAD, TO MAY 31, 1941. R. V. Graham. *The Australian and New Zealand Journal of Surgery*, XI, 185, 1942.

The author presents a series of 128 knee operations performed in an area which had been previously considered unsafe for operations during the summer months, because of the excessive dust and heat. Most of the patients gave a history of previous knee derangements, the commonest cause being injury during football. The most frequent symptom described was "giving way" or a sense of insecurity of the knee. True locking was noted in only forty-two cases. On examination only two patients were seen while the knee was locked. Limitation of flexion was observed in seven cases and of both flexion and extension in eight cases. Undue anteroposterior mobility was present in twenty cases. Local tenderness was elicited in fifty-five cases. Effusion was found in forty-one knees. In nineteen instances, a click could be elicited when the flexed knee, while held with the leg abducted and externally rotated, was brought into extension. In a few cases of tears of the medial meniscus, there was local swelling over the involved meniscus, while similar localized swelling was present in every instance of cyst of the external meniscus. Roentgenograms were not of value in any case of derangement of the medial meniscus. Two knees, in which osteochondritis was found at operation, showed no roentgenographic findings. In two cysts of the lateral meniscus, the films showed flattening of the lateral condyle of the tibia with a small spur on the lateral articular margin of the tibia.

Spinal anaesthesia was used. Hemostasis was obtained by means of a sterile tourniquet made from an old inner tube. Arthrotomies were performed through a parapatellar incision one and one-half inches long. As much of the meniscus as possible was dissected out. In the early cases of the series, the skin was closed with catgut, and a compression bandage was applied. It was found, however, that many of the skin wounds broke down, apparently as a result of excessive perspiration of the skin. Subsequently the skin has been closed with interrupted silk sutures and no compression bandage has been used. A small flat dressing is placed on the skin wound for seventy-two hours. The dressing is then removed and the wound is painted with compound tincture of benzoin. Early active use of the quadriceps is insisted upon, active exercises are started in forty-eight hours, and the patient is allowed to walk after seventy-two hours. No crutches or cane are allowed, and the patient must walk without a limp. The author has found that post-operative effusion disappears with active use.

The average hospital stay in this series of cases was forty-two and one-half days, after which the patients were returned to light duty. Full duty was resumed after an average of seventy-five days. Of the 128 cases in this series, 104 are now on full duty.—

Daniel H. Levinthal, M.D., Chicago, Illinois.

ANKYLOSIS OF THE JAW: CARTILAGE GRAFT RESTORATIONS OF THE JOINT: A NEW OPERATION. II. P. Pickerill. *The Australian and New Zealand Journal of Surgery*, XI, 197, 1942.

Previous operations employed in cases of ankylosis of the jaw include Esmarch's resection of a wedge of bone from the angle of the jaw, and arthroplasty procedures. The author objects to Esmarch's operation because it does not attack the seat of the pathology, it robs the patient of the use of important muscles of mastication, and interferes with the growth of the mandible. Maintenance of the space between the bone ends is difficult, occlusion is disturbed, and the mandibular artery, vein, and nerve are divided. Arthroplasty is not satisfactory because, in addition to being a difficult technical procedure, it produces only a pure hinged joint with no lateral movement, and there remains an unnatural stiffness of mandibular motions, the jaw coming to a sudden stop when the mouth is opened.

The following new operation is advocated. A Z-shaped incision is made over the temporomandibular joint. The neck of the condyle is exposed, stripped, and divided with a Gigli saw. Two pieces of rib cartilage one inch long are shaped, one to fit the glenoid fossa and one to fit the neck of the condyle, and these are then sutured in place with silk.

The author claims the following advantages for his operation. It interposes in amount and character a tissue very "like" that removed. The anatomical arrangements for mastication are restored. Rib cartilage adheres very quickly to surrounding tissue. The author further states that his procedure has resulted in free and natural movements of the jaw including lateral motion.—*Daniel H. Levinthal, M.D., Chicago, Illinois.*

FRACTURA DE BENNET (Bennett's Fracture). Héctor Ordóñez Ferreyra y Héctor Martínez Carranza. *Boletines y Trabajos de la Sociedad de Cirugía de Córdoba*, II, 263, 1941.

This paper discusses Bennett's fracture in general, and analyzes eight cases of the authors. In a review of the literature, they state that Bennett first described this fracture in 1880 and that since then all fractures of the proximal end of the first metacarpal have been called Bennett's fracture. It is possible to subdivide these fractures according to the type of fragmentation and the obliquity of the fracture, and the authors give the detailed classification of Kuss. The authors' cases were treated by means of traction. Skeletal traction with a small wire was used in five cases, and adhesive-tape traction in the other three. In a general discussion of the subject, the authors point out the case with which the deformity recurs if it is given the opportunity. They state that, because of the importance of the joint of the proximal end of the first metacarpal, a malunited fracture will give 15 to 20 per cent. permanent disability of the hand. This joint is involved in all motions of the thumb and especially in opposition. The authors go into the various movements of the hand in great detail in order to emphasize the importance of securing a good reduction in this type of fracture. The various anatomical and physiological considerations involved in applying traction to this fracture are discussed. There are many ways of making the traction, and each is presented, with its advantages and disadvantages. The disadvantage of using adhesive tape is that the tape may become loosened in the course of time. They conclude that traction by means of wire is in general the best, and describe in detail their exact method of applying it. All of their eight patients made a satisfactory recovery, and the authors are convinced that

traction is necessary in all cases of Bennett's fracture. The paper is scientifically prepared and well presented, and is an excellent treatise on the subject of this important fracture of the hand.—*Louis W. Breck, M.D., El Paso, Texas.*

ENFERMEDAD DE HOFFA (Hyperplasia of the Retropatellar Fat). Vicente J. Bértola y Dante J. Baistrocchi. *Boletines y Trabajos de la Sociedad de Cirugía de Córdoba*, II, 313, 1941.

A case of marked hyperplasia of the fatty tissue below the patella and behind the patellar ligament is presented. This condition was first described by Hoffa in 1904, and is frequently called Hoffa's disease. The patient was an Italian woman, sixty years old, who had had an injury to the knee four years previously. The knee was not painful. There was a mass the size of a small orange, which felt lobulated below and medial to the patella. There was slight tenderness on palpation and a very fine crepitation. There was very little limp, but a slight amount of pain was produced on forced extension. The roentgenograms showed a slight amount of bone atrophy, and the tumor mass was definitely distinguishable, in both the anteroposterior and lateral views, as a soft-tissue tumor. Pneumo-arthrogram (roentgenogram after air injection of the joint) showed the mass to be not connected with the joint. The serology for syphilis was negative, and the general examination of the patient revealed nothing of importance. On the basis of the foregoing history, examination, roentgenograms, and laboratory findings a preoperative diagnosis of Hoffa's disease was made. Under local anaesthesia, and employing a large U-shaped incision, the fatty tumor mass was excised. It was sixteen centimeters in diameter, lobulated, and fairly discretely defined. It was adherent to the periosteum of the tibia in one area. The capsule of the joint was so distended that it was hard to define in places, and in general the dissection was rather difficult. The article is well illustrated with roentgenographic reproductions, drawings, and photographs.—*Louis W. Breck, M.D., El Paso, Texas.*

CAISSON DISEASE (COMPRESSED-AIR ILLNESS) OF BONE WITH A REPORT OF A CASE. Valentine A. J. Swain. *The British Journal of Surgery*, XXIX, 365, April 1942.

Caisson disease is the result of injuries to tissues by liberated bubbles of nitrogen, when the body is too rapidly decompressed.

A patient of thirty-seven years, a general laborer, complained of pain in both shoulders and in the right hip. He had been employed in underground work until sixteen months before admission, and for four years before that he had worked in compressed air.

Roentgenographic examination showed a marked avascular necrosis of the articular surface of the head of the right humerus, with similar but lesser changes in the left. Two months later he died of coronary thrombosis. At autopsy, the appearance of the humeral heads was that of aseptic necrosis of the bone, compatible with a sudden vascular occlusion at a previous date.

The writer states that in caisson disease the lesions of bones are infarcts, which are produced by nitrogen emboli. These lesions are usually found in the long bones and are usually multiple. He states that it is quite possible that many more of these late lesions will be seen in "those who work in the bowels of the earth, soar to great heights, or descend into the depths of the sea".—*Ernest M. Daland, M.D., Boston, Massachusetts.*

TUBERCULOSIS OF THE SPINE: OBSERVATIONS ON LOCALIZATION, EXTENSION AND HEALING—THEIR BEARING ON DIAGNOSIS AND TREATMENT. J. V. de los Santos. *The Bulletin of the Quezon Institute*, I, 283, 1941.

The author has published a very interesting article on "Tuberculosis of the Spine". His excellent "Summary and Conclusions" are quoted as follows:

"The present study is based upon 74 clinical cases of tuberculosis of the spine

examined roentgenologically. Twenty-one of these cases came to necropsy and the spines were studied both roentgenologically and pathologically in an attempt to determine the localization, extension and healing of the tuberculous spinal infection.

"The intervertebral articular type of the spinal localization has been found roentgenologically and pathologically to be the most common. The incidence is greatly increased by the rather large number of cases with posterior juxta-articular localization, which generally fails to show roentgenologically until late in the disease after marked structural changes have already taken place. The central type of localization comes next in frequency.

"The tuberculous infection may find lodgement in a number of distant vertebral bodies. As high as 40 per cent. of the cases pathologically studied showed multiple vertebral localization.

"The spinal infection appears to follow no definite course or pattern and its extension depends to a great extent upon its initial localization. While its common course is towards the spinal canal and laterally, yet in a few instances it pursues its way along the anterior and posterior spinal ligaments with secondary involvement of the vertebra and the intervertebral discs. Although the intervertebral discs in adults appear vulnerable to the infection, in children in most instances the discs are quite resistant to it and escape involvement in spite of destruction and even collapse of adjacent vertebral bodies.

"During the extension of the infection sequestra of various sizes are commonly formed but they remain generally unrecognizable in the roentgenogram.

"Fine and early sequestra are frequently made up of bone plates or ossified epiphyses following invasion by tuberculous granulation tissue. A primary epiphyseal involvement, however, has not been seen so far either from the microscopic examination or in the roentgenogram taken of a slice of the bone. The sequestra are commonly found on the anterior and posterior edges of the vertebra and are detected only upon roentgenological examination of a thin slice of the bone and upon microscopic study.

"Bilateral (kissing) sequestra are at times encountered in spite of the presence of intact intervertebral discs. Contrary to König's theory of embolism, their formation appears to result from secondary invasion of the bone by granulation tissue, as has also been mentioned previously by Phenister.

"Aside from the common subjective and objective symptoms, roentgenological manifestations of spinal caries are important in establishing the diagnosis. The recognition is based upon the appearance of bone changes—usually in the nature of defects—in the various regions of the vertebra, which form the frequent sites of localization of the tuberculous infection; namely: intervertebral or juxta-articular, central and anterior.

"The presence of abscess shadow about the lesion is an important finding but is not essential in the diagnosis. The same holds true with the angular deformity or gibbus of the spine.

"Osteoperiostitis along the regions of the anterior and lateral spinal ligaments as well as new bone formation on or about the small intervertebral articulations, spinous ligaments and ligamenta flava in arrested and healing tuberculous lesions is a significant finding.

"Repair of the spinal lesion is usually effected by fibrous tissue replacement. In some instances, however, osseous repair takes place, but the amount of bone replacement, as a rule, is meagre and incomplete.

"The healing of the lesion is usually accompanied by the formation of new bone on or about the vertebral bodies and the small intervertebral joints; and likewise by ossification of the spinous ligaments and ligamenta flava included in the diseased segment of the spine, notwithstanding the absence of secondary infection.

"The new bone formation, which in some instances has been found to be pronounced about the spinal lesion and the posterior arch, serves, to a certain degree, as a guide in the selection of any surgical attempt at stabilization by internal fixation of the diseased portion of the spine. In the event it is found advancing and marked, internal fixation may be unnecessary and at times even harmful to the repair processes."

CALCIUM, PHOSPHORUS, NITROGEN AND MAGNESIUM METABOLISM IN NORMAL YOUNG CHINESE ADULTS. H. I. Chu, S. H. Siu, H. C. Hsu, H. C. Chao, and S. H. Chew. *The Chinese Medical Journal*, LIX, 1, 1941.

This study was made on normal Chinese adults of both sexes, to determine the calcium, phosphorus, nitrogen, and magnesium metabolism, and the effect of therapeutic doses of vitamin D. The conclusions are:

The average calcemia of the male group was 10.29, and of the female group, 9.86. Neither individually nor as a group was there any difference between the serum calcium levels before and after the administration of vitamin D.

The serum inorganic phosphorus has an average value of 3.99 milligrams per 100 cubic centimeters. There is a small difference between the two sex groups, the value being higher in the female. Vitamin D did not produce any changes in the serum inorganic phosphorus.

The serum phosphatase averaged 1.68 units per 100 cubic centimeters, and was a little higher in the females.

The serum magnesium average was 2.75 per 100 cubic centimeters.

The average maintenance of calcium requirement for an adult Chinese was calculated about 7.3 milligrams per kilogram per day. The phosphorus maintenance requirement needs an intake of 13.6 milligrams per day. Magnesium maintenance was about 5.5 milligrams per kilogram per day.

The paths of excretion are as follows:

Calcium. The male group excreted more calcium (25 per cent.) in urine than the female group (15 per cent.). Administration of vitamin D seemed to be followed by an increase of urinary calcium excretion. It is possible that vitamin D, while incapable of promoting calcium retention in normal persons, tends to alter the path of calcium elimination in favor of the urinary tract.

Phosphorus. The average urinary excretion is 60 per cent. of the total excretion. No difference between male and female was found, or any variation after the administration of vitamin D.

Magnesium. The urine magnesium represents 29 per cent. of the total magnesium output. No difference between the sexes was found, and no variation after the administration of vitamin D.—*José Puig, M.D., Iowa City, Iowa.*

SERIOUS COMPLICATIONS OF RUPTURED INTERVERTEBRAL DISKS. Walter E. Dandy. *The Journal of the American Medical Association*, CXIX, 474, June 6, 1942.

The author presents three quite interesting cases of serious complications following ruptured discs,—one in the cervical region, which resulted in necrosis of the cord and death; one in the thoracic region, with paraplegia partially relieved by operation; and one in the lumbar region, with permanent sensory loss and incontinence. These cases, together with two others previously reported and one not reported, comprise a total of six cases of serious complications out of a total number of 300 patients operated upon.

The author stresses the importance of early diagnosis and operation for rupture of the cervical and thoracic discs before permanent damage results, and it is in these cases only that he feels the use of iodized oil is indicated.—*Brandon Carrell, M.D., Dallas, Texas.*

LUMBAR PUNCTURE. ITS POTENTIAL ROLE IN THE PRODUCTION OF INJURIES TO THE INTERVERTEBRAL DISK. Donald Munro and Warren G. Harding, 2d. *The Journal of the American Medical Association*, CXIX, 482, June 6, 1942.

The authors demonstrate that perforating injury to the posterior part of the annulus fibrosus is a distinct possibility during the course of lumbar puncture, and advise that this procedure be performed cautiously and with the spine extended rather than flexed. The conclusions were warranted by lateral roentgenograms taken during the course of myelography by a two-needle technique. It was demonstrated that 36 per cent. of the needles

were in a position which would have penetrated the annulus fibrosus if they had been inserted farther in the line of their course. The distance between the point of the needle and the surface of the annulus averaged between four and five millimeters. The findings also indicated that the interspace between the fifth lumbar and first sacral vertebrae is safest, and that the third and fourth interspaces should be avoided if possible.—*Brandon Carroll, M.D., Dallas, Texas.*

A SIMPLE SKELETONIZED PLASTER SPLINT FOR THE CERVICAL SPINE. Sam W. Banks, Edward L. Compere, and Charles Watson. *The Journal of the American Medical Association*, CXIX, 631, June 20, 1942.

This article describes a simple way of making a light-weight plaster splint, instead of a metal brace, for use in the treatment of a fractured cervical spine. The splint is light and resembles the type of metal brace widely used. Its advantages of course are that the total cost of materials does not exceed four dollars.—*Clyde B. Treves, M.D., Dallas, Texas.*

THE DEVELOPMENT OF SARCOMA IN MYOSITIS OSSIFICANS. REPORT OF THREE CASES. George T. Pack and Ralph R. Braund. *The Journal of the American Medical Association*, CXIX, 776, July 4, 1942.

Following a description of myositis ossificans and a short synopsis of the cases that have been reported, the authors present a short classification of the different types and manifestations of the disease.

In a review of the literature, five cases were found in which the bony tissue of myositis ossificans underwent malignant neoplastic change. Two new cases are added to these, complete with case histories, physical findings, and roentgenograms and photographs. A third case of myositis ossificans progressiva was associated with malignant tumor, probably myxoliposarcoma.—*H. H. Beckering, M.D., Dallas, Texas.*

THE PRINCIPLES OF FRACTURE TREATMENT. A. T. Andreasen. *Journal of the Indian Medical Association*, XI, 158, March 1942.

The author discusses the modern principles of fracture treatment as logical outgrowths of the pioneer orthopaedic work of Hugh Owen Thomas and Robert Jones. He describes the histological, biochemical, and pathological aspects of bone repair, and the relation between vascularity and the rate of repair. The basic law of fracture treatment is that every fracture must be completely immobilized in anatomical alignment without interruption until the fragments are firmly united. The immobilized part, encased in plaster, should be actively used throughout the period of healing to prevent muscle atrophy and joint adhesions. This technique gives better results than massage and passive movement.—*Robert M. Green, M.D., Boston, Massachusetts.*

A SEQUEL OF KNEE LIGAMENT STRAIN: PELLEGRINI-STIEDA'S DISEASE (METACONDYLAR TRAUMATIC OSTEOOMA). W. R. Hamsa. *Nebraska State Medical Journal*, XXVII, 62, February 1942.

The characteristic feature of this condition is the presence of an area of new bone or calcific change in the region of the medial femoral condyle, presumably the femoral end of the medial collateral ligament. The condition develops following direct or indirect trauma, and is most common in active adults. The earliest symptoms are those of synovitis—pain and swelling—followed by some improvement but not complete recovery. Limitation of motion may occur gradually and become progressive. Tenderness is localized over the medial aspect of the medial femoral condyle. Gradual enlargement of this condyle, either bony or calcific, may or may not be the cause of the disability. Joint

relaxation and injury to semilunar cartilage may contribute greatly to the disability. The process seems similar to myositis ossificans.

Treatment consists of (1) immobilization in a splint or cast to remove all stimuli which may increase bone formation; and (2) deep heat, preferably diathermy, to facilitate absorption. Surgical removal is seldom necessary as the enlargement is rarely sufficient to give rise to a mechanical disorder.

The rapidity with which an area of increased density within the area of ligament attachment may appear on roentgenograms following injury is not appreciated, and for this reason alone this case report is justified.

A plasterer, thirty-nine years old, complained of pain and disability of left knee following a fall which turned the left leg into marked valgus and produced severe pain. On attempting to walk he felt a snap in the knee which became freely movable but developed moderate swelling. Five days following injury, the roentgenogram showed no bone change; but eighteen days following injury, it showed calcification above and medial to the medial femoral condyle, and was interpreted as an old injury. Three months after the injury, a tender palpable hard mass appeared over the medial femoral condyle, and the roentgenogram showed the fairly smooth outline of the calcifying area proximal to the medial condyle of the femur. This case illustrates one of the earliest appearances on record.

Surgical removal in the majority of reported cases has been followed by recurrence of the bony mass. Surgery would seem to be indicated only after improvement by conservative means has ceased and after the bony mass has shown definite condensation and smooth outline.—*J. Y. Sher, M.D., Iowa City, Iowa.*

COLLES'S FRACTURE. William Darrach. *The New England Journal of Medicine*, CCXXVI, 594, April 9, 1942.

The author describes the anatomy, pathology, symptoms, signs, and treatment of Colles's fracture. He prefers, in the treatment, the use of the "sugar-tong"—single plaster splint—which he generally replaces seven to ten days later, after the subsidence of the swelling, with a circular plaster gauntlet from the mid-palm to the upper forearm. The sugar-tong splint is applied so as to allow free motion of the interphalangeal and metacarpophalangeal joints, and finger movement is encouraged.

When the plane of fracture is oblique, or when there is comminution of the dorsal surface, there is a strong tendency, because of the muscle pull, for the dorsal shift and tilt to recur. This can be partially overcome if the splint is applied with the wrist in strong flexion and moderate adduction.

If the comminution is so extensive that no form of splint alone prevents collapse and shortening, he advises using double Kirschner wire and plaster, one wire through the bases of the second, third, and fourth metacarpals and the other higher in the forearm in the upper ulna, just distal to the coronoid. Reduction is obtained by traction on the wires, and a cast is applied incorporating the two wires. These are left in place for from five to seven weeks.

He describes the late disabilities and their treatment, but these do not differ from those described elsewhere, and their treatment is also similar to present accepted methods.—*S. A. Adland, M.D., Iowa City, Iowa.*

MECHANICAL FIXATION OF FRACTURES. Charles H. Bradford. *Proceedings of the Royal Society of Medicine*, XXXIV, Part II, 786 (Section of Orthopaedics, p. 37), 1911.

In addition to the three accepted methods of treating routine fractures—closed reduction, open reduction, and traction—the author suggests a fourth method derived from the principles of mechanical fixation. This is done by fixing the fracture at both ends by means of pins or screws, and then using these fixation units to accomplish reduction and immobilization of the fracture. The three important factors in the use of this method are:

1 The danger of contamination from the pins. This the author feels is minimized by strict asepsis, by normal tissue resistance, and by the fact that in this method of immobilization, the pins are rigidly fixed. (However, he does feel that, with the use of pins, the wound should be considered potentially infected.)

2 The problem of adapting a machine to the complicated manoeuvres of fracture treatment. Although the surgeon may at first experience difficulty in substituting the complex apparatus for the familiar manipulations, repeated schooling will permit him to reproduce every manoeuvre.

3 The effect of such treatment on union of the fragments. The author warns that any treatment which tends to fix fracture ends in a position of distraction may delay or even prevent union. In the application of rigid pin fixation which allows no backward slipping, this is an important factor. To obviate this, the author releases the traction screw and forces the fragments together after reduction. He calls it "controlled impaction".

The advantages of this method are as follows:

1. It is a more powerful and more accurate means of reducing difficult fractures.
2. After the reduction is complete, it provides a vicelike form of fixation.
3. Such fixation properly applied avoids the delay in union produced by distraction.
4. It allows free ambulation from a very early period.

This mechanical fixation has proved its worth in the treatment of difficult fractures, particularly in those which have passed the stage where simple attempts at closed reduction would be effective.

The author states that inasmuch as war fractures are frequently compound and require open reduction, the Orr method does not offer a satisfactory solution, as it fails to meet the fracture requirements. The treatment suggested can readily be used in the presence of infection and can be combined with the closed-plaster method.

The importance of ambulatory treatment in time of war is stressed. Forty-one patients received this treatment, but follow-up studies have not been obtained because of the short postoperative period. Thirty-three of the cases involved the lower extremities. All the patients were seen comparatively late, the interval being over two weeks in twenty cases. Only three patients were seen within forty-eight hours. No detailed statistical results are given, but several cases with remarkable results are cited to illustrate the possibilities in the use of mechanical fixation.

Of the forty-one cases, a bone infection at the pin site developed in only one, this was a low-grade infection in a patient with a badly infected compound fracture. The patient responded to treatment.—*S. M. Albert, M.D., Iowa City, Iowa*

SOBRE A FRATURA ISOLADA DA ESTILOIDE CUBITAL (On Isolated Fractures of the Styloid Process of the Ulna) Achilles de Araujo *Revista Brasileira de Ortopedia e Traumatologia*, III, 71, 1941

The author believes that this fracture has not been sufficiently studied. It was first mentioned by Voisin in 1833, and has been described in more detail by others since then. Although found to be more frequent than previously thought, this fracture has not attracted enough attention. In most of the modern and recent textbooks no mention of this fracture is found.

In the records of the author's clinic, only twelve such cases were registered in a period of twenty years. The fractures occurred only in males between fourteen and forty years of age, mostly on the left side, and involving more frequently the base of the styloid process. This observation corresponds to the facts obtained by other surgeons in the thirty-eight cases which the author could find in the literature. In most of the observations the fracture occurred as a result of an indirect trauma, from a sudden and violent rotation of the radial side of the hand. The author believes that the mechanism is one of avulsion produced by exaggerated tension of the ulnar collateral ligament of the wrist.

A fine description of the pathological anatomy and the symptomatology of this injury is followed by recommendations for treatment. Immobilization followed by physiotherapy is advocated. Infiltration by novocaine, as devised by Leriche, may be useful. In old cases with persistent pain, the removal of the non-united fragment may be necessary.—*Emanuel B. Kaplan, M.D., New York, N. Y.*

FRATURAS DE HUMERO E LESÕES DO NERVO RADIAL (Fractures of the Humerus and Lesions of the Radial Nerve). Mario Marques Tourinho. *Revista Brasileira de Ortopedia e Traumatologia*, III, 144, 1942.

A short review of the literature is presented by the author, showing that in fractures of the humerus with the slightest involvement of the radial nerve, operative intervention is indicated and may even be imperative.

The author describes the possible complete anatomical and physiological section of the radial nerve. Two cases were treated by the author. In both cases surgical intervention followed shortly after the fracture. The radial nerve was not found to be anatomically severed, but its position in relation to the fractured fragments was such that the inclusion of the nerve in the future callus was possible. The author believes that every fracture with immediate signs of involvement of the radial nerve should be treated by open reduction and exploration of the radial nerve.—*Emanuel B. Kaplan, M.D., New York, N. Y.*

RECONSTRUCCIÓN DE LOS LIGAMENTOS DE LA RODILLA. (PRESENTACION DE ENFERMOS) [Reconstruction of the Ligaments of the Knee. (Presentation of Patients)]. Antonio Bonadeo Ayrolo. *La Revista de Medicina y Ciencias Afines*, IV, 102, 1942.

The author presents three cases of reconstruction of the anterior cruciate ligament. Several innovations in technique are presented. A relatively small incision is used, which does not involve the patella, patellar tendon, or lateral ligaments, and which is said to produce much less trauma. A new cruciate ligament is made of fascia lata, which is placed through drill holes in the femur and tibia similarly to the manner used by American authors. An original drill guide is used to put the holes in the right place and at the right angle. The guide consists of a sleeve through which the drill point goes, and is made much like the Kirschner-wire guides, which are familiar. The sleeve, for guiding the drill, points at a pointed arm which is placed where the hole is intended to go. The device would seem to be very ingenious and valuable. The new cruciate ligament is anchored with silk sutures. The author repairs the lateral ligaments by simply resuturing them if this is possible. In one of the cases presented, the external lateral ligament was reconstructed, using the biceps tendon. This tendon was left attached to the fibula and a generous piece of it was dissected free proximally. It was then attached to the external condyle of the femur. Three cases are presented in detail, and excellent results were obtained in all three, according to the author. The article is well illustrated with drawings of the operative procedure using the guide, and photographs of the patients showing the end results.—*Louis W. Breck, M.D., El Paso, Texas.*

PLATYSPONDYLY. Henry G. Hadley. *Virginia Medical Monthly*, LXVIII, 357, 1941.

Platyspondyly is a term first used by Putti, and is derived from the Greek, meaning wide (platy) and vertebra (spondylos). This was mentioned by Nau who described it as "vertebraux bilobés". Hemivertebra or platyspondyly is caused by failure or delay of fusion in the membranous stage of embryological development, while spina bifida may occur in any stage. Platyspondyly occurs only in the membranous stage. Lance describes three types. One usually occurs in the fourth or fifth lumbar, as in the cases of Putti. The second type is a widened vertebral body divided into two cuneiform segments with the apex centrally located, and the bases laterally,—frequently found in the thoracic and cervicothoracic areas. The third type is one in which the superior and inferior surfaces are concave in the center, while the intervertebral discs are convex and higher than normal.—*E. G. Lozano, M.D., Iowa City, Iowa.*

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